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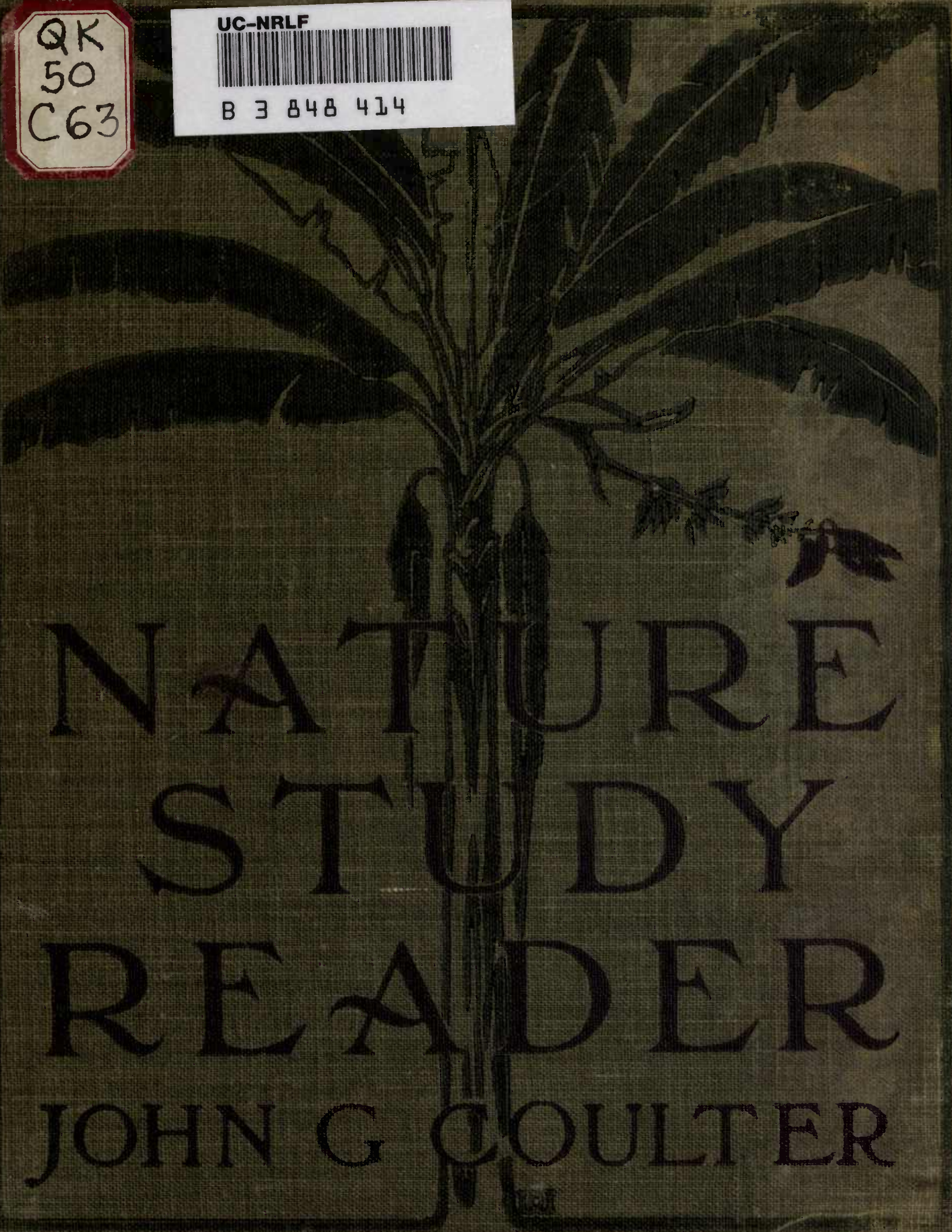
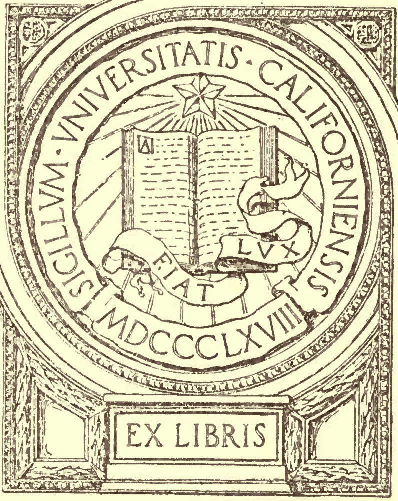


NATURE STUDY READER

JOHN G COULTER

IN MEMORIAM

Richard M. Holman



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A NATURE STUDY READER

Bamboo.

A
NATURE STUDY READER

FOR THE

PHILIPPINE ISLANDS

BY

JOHN GAYLORD COULTER, PH. D.
TEACHER OF BOTANY, INSULAR NORMAL SCHOOL

UNIV. OF
CALIFORNIA

FULLY ILLUSTRATED

NEW YORK
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IN MEMORIAM
Richard M. Holman

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PREFACE

SUCCESS in Nature Study, more than in most other subjects, must depend upon the work of the teacher. The following chapters are very simple in treatment, and previous training in botany on the part of the teacher is not at all essential, yet their use as a reading-text alone is not the thing expected. The pupils should make almost constant use of a note-book and pencil. The plants described have been chosen chiefly on account of their familiarity and availability throughout the Islands, and the pupils should make their sketches directly from nature. They seem to take considerable pride in the preparation of such a "Nature Study note-book," and it is the best aid to accurate observation. The teacher can easily extend the range of topics studied. The thirty chapters should not be exhausted in less than sixty or seventy lessons.

Fundamental principles have been presented through the medium of familiar examples, rather than as independent topics, simply because it has been the experience of the writer that the subject "teaches better" that way, at least in such very elementary presentation. Thus, the familiar papaya is made the means of acquaintance with the uses of the various parts of the plant, rather

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than to take up the topics "root," "leaves," "flowers," etc., in more abstract form. The banana serves to show methods of reproduction. Through pandan, pollination and the light-relation of leaves are introduced. This scheme is followed throughout. At some points the text is suggestive rather than explicit, for the Filipino pupil in Nature Study classes has shown himself quite capable of seeing the more evident reasons for himself. Numerous questions are asked whose answers, though simple, are to be found outside the covers of the book. It is urged that the teacher shall make the questioning so far as possible of this character.

JOHN GAYLORD COULTER.

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UNIV. OF CALIFORNIA

A NATURE STUDY READER

CHAPTER I

WHAT THIS BOOK IS ABOUT

Nature Study is the study of all things out-of-doors which men have not made. Almost always the first things you see out-of-doors are the plants. Plants form the natural covering of nearly all the land surfaces of the earth. They are living things, just as men and other animals are living things. Without plants, men and other animals would die. This book tells about some of the common plants of the Philippine Islands.

In every country of the world plants are very important in the life of men, but in no country are they more important than in the Philippine Islands. What do you think would happen to the Filipino people if all the plants died to-morrow? How long do you think the people could live?

Many parts of the world can not be used for the growing of plants which produce food and other valuable products because the soil is not fertile. Regions of the earth whose soil produces very few plants are called desert regions. People who live in such parts of the world must get much of their food from other parts. A country whose chief industry is the growing of plants to produce food for other parts of the world is called an agricultural country. The Philippine archipelago will become one of the best agricultural countries in the world when her people have learned how to make the most out of her rich lands. This is one reason why it is important for you to learn about plants and how they live.

All our food and nearly all our money come from plants. We have food which comes from animals, but the animals get their food from plants. So if there were no plants there would be no animals.

A dry country (Arizona), producing very few plants.

It is not so easy to see how nearly all the money of the Filipino people comes from plants, but it is just as true. Many countries are rich because they have mines of gold and silver, or mines of copper and iron and coal. Other countries are rich because they have great factories where clothing and shoes, tools and machinery, and many other necessary things are made. The Filipino people do not have many factories and have very few mines. They have instead a country in which many of the most valuable plants in the world can grow, and nearly all their money comes from selling the products of these plants. Much money is paid for the products of all the mines, and much is paid for the products of the factories, but both together are not worth so much as the products of the plants of the world. Men could live without factories and they could live without mines, but without plants they would very soon die.

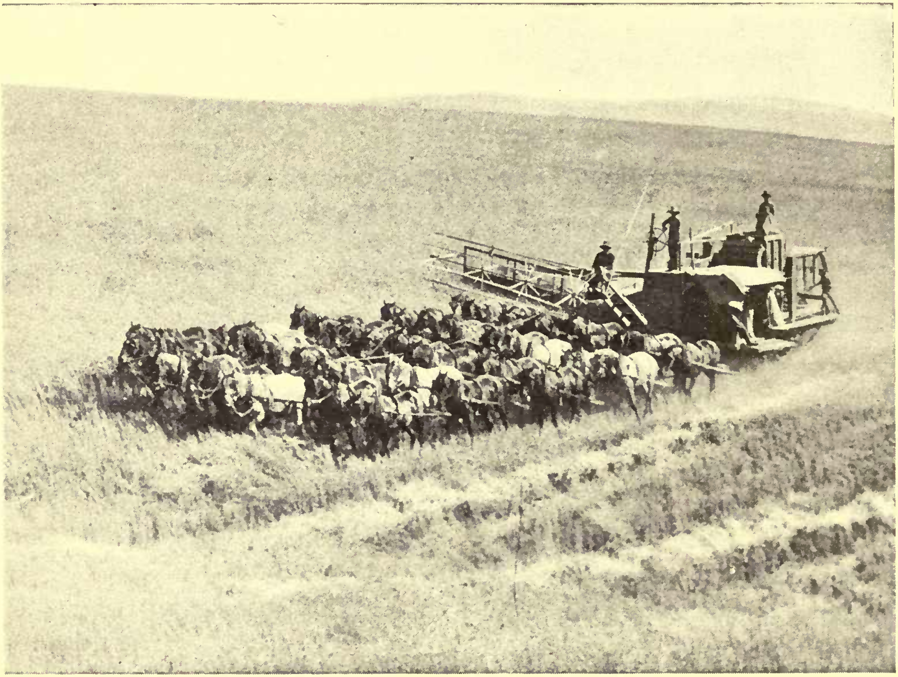
If the Filipino people use their rich land to produce in the best way the many valuable plants which grow here, they will become quite as rich and prosperous as people who have many mines and factories. In other countries it is not possible to grow many of the valuable plants which grow here, and the people of these countries are glad to pay a good price for the plant-products of our fertile islands. So it will be a very good thing for the Filipino people when they have learned how to produce enough plant-products for their own use and much besides to export to other countries.

In these beautiful and fertile islands it is possible to produce more than five times as much as is now produced. At this time (1904) the Filipino people buy from other countries just as much as they sell to them. It is easy to see that no people can become very rich until they sell more than they buy. When our Filipino farmers

An agricultural country. Reaping and loading wheat by machinery in the Western States.

have learned how to get the best crops from their farms, this may become true for the Philippines.

In Nature Study you will gain knowledge which is necessary for a good understanding of the best ways to cultivate plants. The products of plants are made much more valuable when the plants are cultivated. To cultivate a plant means to help it grow. Rice is a cultivated plant because the farmer works hard to help it grow and produce a good crop of rice seeds. In Nature Study you will learn something of the cultivation of plants. You will learn how plants



American harvester and thrasher combined.

live and how they produce their young. You will learn what are their friends and what are their enemies. When we cultivate plants we help their friends and try to destroy their enemies. You will learn that animals are necessary helpers in the cultivation of plants. You will learn the work which each of the different parts of the plant has to do, and how this work is done.

Plants which men do not cultivate are called wild plants. Many valuable plants grow wild in the Philippine Islands. Cultivated plants grow in the fields and in the gardens. Wild plants grow in the forests and along the shores and in many other places. It would be very hard to find a place in the Philippine Islands where neither wild nor cultivated plants can grow.

Most of the plants which you will study about in this book are cultivated plants, but the very first one you are to study about is a plant which is very common, but which grows without cultivation. It is the papaya.

CHAPTER II

ABOUT THE PAPAYA

THE papaya is a plant which grows everywhere in the Philippine Islands and has very few enemies. You have already learned that plants have friends and enemies. Thus, the grasshoppers and dry weather are great enemies of the rice.

Since the papaya has very few enemies which it is not able to overcome, it is not necessary for men to cultivate it or help it grow. The fruit of the papaya is good food and it seems to be about as good when the papaya grows wild as when it is cultivated, but the fruit will grow larger when some of the young fruits are cut away to give the others more room.

One of the reasons why the papaya has very few enemies is because it can live in ground which other plants cannot use. It is common to see the papaya growing among rocks where the soil is very poor. For this reason other plants do not try to crowd it out, as the macahia tries to crowd out the rice. The papaya is a very strong and healthy plant. If it were not strong and healthy it could not grow so well where the soil is very poor and dry.

The life of papaya is something like the life of the wild people who live in the mountains of the Philippine Islands. These people take the poor parts of the islands for their homes and so the other people leave them alone, for no one cares to crowd them out of the poor places. In the same way the papaya takes the poor parts of the soil for its home and the other plants do not try to crowd it out.

Every Filipino boy or girl knows that there are two kinds of papaya. What do you call the two kinds? In English they may be called the man-papaya and the woman-papaya. How can you tell these two kinds of papaya apart? Are the leaves different? Are the stems different? Are they the same height? Do they have the same kind of flowers? Do both kinds produce fruit?

The papaya is a very good plant for us to study first because it will show many things about the life of plants which are more difficult to see in other plants. The life of one plant is very much like the life of all the rest, so that what we learn by studying the papaya is true also for thousands of other plants.

The papaya shows very plainly the different parts of the flower. Since there are two kinds of papaya flowers we find in each kind of flower just one-half of the parts which we find in a perfect flower. Plants which have just one kind of flower must have all the flower-parts together and we call these flowers perfect flowers. The gumamela, for example, has perfect flowers. But the papaya has half the flower-parts in the flower of the man-papaya and the other half in the flower of the woman-papaya. You can easily see in the pictures the difference between these two kinds of flowers. By looking carefully at the flower of the woman-papaya, and then at the flower of the man-papaya, can you see why one produces fruit and the other does not?

Have you ever seen a papaya-fruit upon a man-papaya tree? Sometimes a small fruit is formed at the very end of the flower-branch of the man-papaya. When you see such a tree, you should look carefully

The man-papaya.

to see whether the flower at the end of the flower-branch is different from the others. Are the flowers from the woman-papaya borne on branches or on the main stem ?

How soon can you tell whether a young papaya is going to be a man-tree or a woman-tree ? How high does the plant grow before it begins to produce flowers? Some people say that if you cut off the stem of a young man-papaya tree just after it has produced its first flowers it will become a woman-papaya when it grows up again. Do you know whether this is true ?

The stems of the papaya are very different from the stems of other plants. When you break off one of the old leaves of the papaya it leaves a mark on the stem. Have you ever noticed these marks? Can you see them better on the old part of the stem or on the young part at the top ?

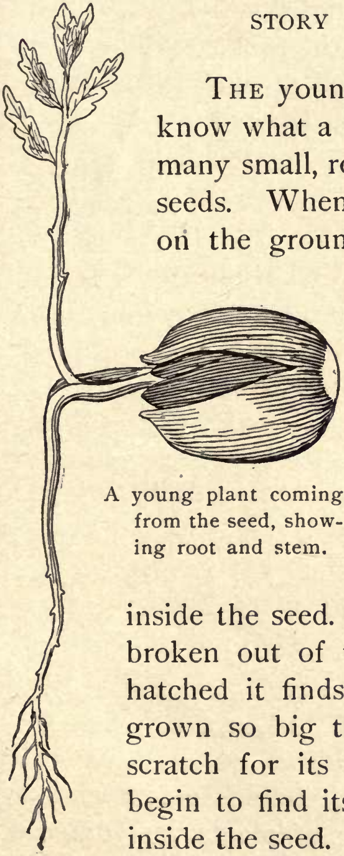
Since the leaves of papaya are very large it is not necessary for the plant to have many of them. They are all borne at the top of the stem. The top part of the stem and the leaves form what is called the crown of the plant. What other common plant has very large leaves and only a few of them in a crown at the top of the stem ?

The papaya grows in many other tropical countries besides the Philippine Islands, and everywhere in the tropics its fruit is good to eat. In temperate countries like the United States the papaya may be grown in the gardens if it is protected from the cold of winter, but in these countries it does not produce good fruit.

The parts of a plant which are underground are called roots. Do the roots of the papaya go very deeply into the ground or are they near the surface ? Are the papaya-plants blown down easily by storms ? Do young papaya-plants ever grow up from the bottom of the old papaya-plants like the young bananas which grow from the bottom of the old banana-plant? How do you think the young papaya grows? In the next lesson you will read the story of the young papaya.

CHAPTER III

STORY OF THE YOUNG PAPAYA



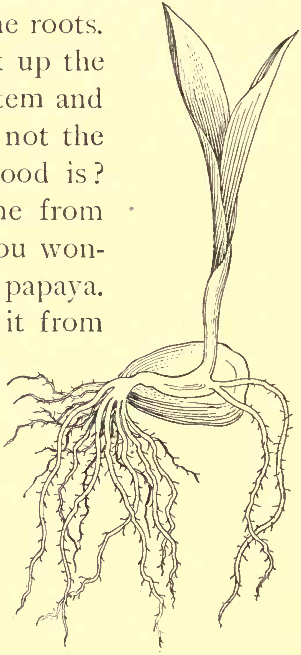
A young plant coming from the seed, showing root and stem.

The young papaya grows up from a seed. Do you know what a seed is? Inside the ripe fruit of papaya many small, round bodies may be found. These are the seeds. When the seeds are scattered in a good place on the ground they will begin to grow into young papaya-plants, unless the chickens or some other enemies find them and eat them up.

Now a plant must have food just like men and animals. When the papaya is a very young plant indeed it gets its food from inside the seed, but soon the young papaya has grown larger and has eaten up all the food which was stored for it inside the seed. It is like a little chick which has just broken out of the egg-shell. Before the little chick is hatched it finds its food inside the egg, but when it has grown so big that it breaks the shell it must begin to scratch for its own food. So the young papaya must begin to find its own food after it has eaten everything inside the seed.

The little chick has three parts which help it get its food. It has eyes to look for food, legs to run and get it, and a beak for picking it up.

The young papaya has nothing like eyes and legs and beak, yet it must have food just like the chick. The three parts of the papaya which help it for this purpose we call the root, the stem, and the leaves. Since the papaya can not run around and find its food, you might think that it gets its food in the ground where it grows and that the food is taken up by the roots. But this is not quite true. If the root took up the food of the papaya what do you think the stem and the big leaves would be for? Why would not the whole plant live underground where the food is? No, the food of the papaya does not come from the ground. It comes from the leaves. You wonder how the leaves get the food of the papaya. Do they get it from the air? Do they get it from the water which comes up to the leaves from the ground? No, the leaves do not *get* the food of the papaya-plant at all. They *make* it. The leaves of the papaya are like little workshops and in them the food of the plant is made.



Another young plant, with roots further advanced.

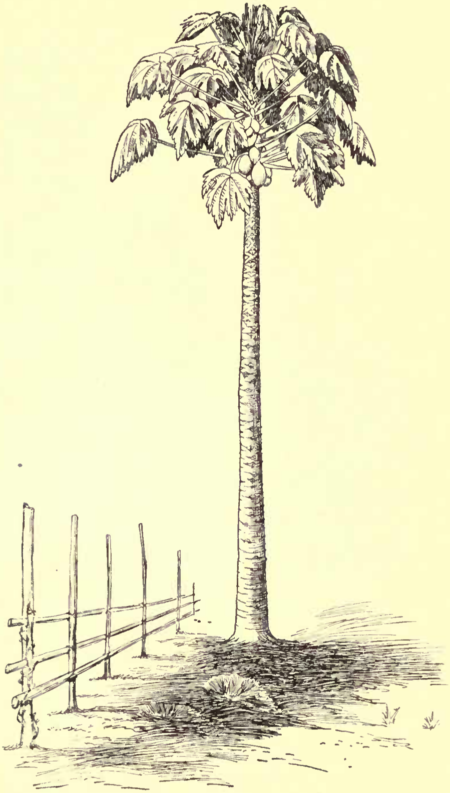
You can see that in this way the young papaya is very different from the young chick. Both must have food, but the chick goes around and finds its own food, while the food of the papaya is made in its leaves. This is a thing which you should remember very well, for it is a thing that makes the lives of plants very different from the lives of animals. Each must have food, and what is food for a plant is also food for an animal, but the great difference is that an animal gets its food already made, but a plant makes its own food.

After we have learned that the leaves of the papaya are for making the food of the plant, we should learn what the roots and the stems are for. Let us think of a young papaya which has used up all the food inside the seed. What is it going to do next? Can the young leaves begin to make food without any help from the roots and the stem? No, the roots and the stem must help. If we could watch a young papaya as it begins to grow, we would see that the first part of the plant which comes out from the seed is the little root. This is the part of the plant which must begin the work of helping to make food.

If we are going to make a dress or a coat, the first thing we must do is to get the cloth out of which the coat or the dress is to be made. In the same way the young papaya must get the material out of which food is made, and it is the work of the root to get this material. So the young root begins to grow down into the soil and there it finds the things which the leaves know how to make into food. These things are in the water of the soil, and when the root takes up this water it takes into the plant the things which are in the water. You all know that there is salt in the water of the sea. You all know that when you put a lump of sugar into coffee it is soon dissolved in the coffee. In the same way the things which the plant uses in making its food are dissolved in the water of the soil.

While the root of the young papaya has been growing down into the soil, the stem has been growing up into the sunlight. When the stem has grown up a little way the young leaves begin to unfold and spread out in the light. They seem to be trying to get all the light they can. Light is necessary to help the leaves make food.

Perhaps you can think for yourselves now what the stem is for. When the leaves have opened up and the light is shining on them, they are ready to begin the work of making food. Already the root has begun to take up the water of the soil and in this water are the things out of which the leaves can make food. The water passes along the stem until it reaches the young leaves. Then the little workshops begin their work. All day while the light is shining on them they are busy making food for the plant. In the night the food which is made in the leaves of the young papaya passes into the stem and goes to feed all the hungry parts of the plant.


The woman-papaya.

Now you can see what each of these three parts of the young papaya-plant has to do. Every part of a plant has some work to do.

It is the work of the root to hold the plant firmly in the ground and to get the material out of which the leaves can make food.

It is the work of the leaves to make food for the plant. They could not do this work without the sunlight which gives them the power to do it.

The stem has three kinds of work. First, to lift the leaves up into the sunlight. Second, to carry up to the leaves the water which comes from the root. Third, to carry the food which is made in the leaves down to all hungry parts of the plant.

CHAPTER IV

ABOUT PAPAYA FLOWERS

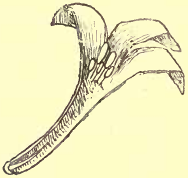
After the young papaya has learned how to use its roots and stems and leaves, it grows very rapidly. Do you know how long it takes a papaya to grow up from a seed and bear fruit? There are some trees which take eight or ten years to become as large as a full-grown papaya, but if you watch a young papaya you may see that it grows several inches in a few weeks.

The food which is made in the leaves is used in making the new parts of the plant. When the papaya has learned how to find its food and how to grow you might think that it has learned all there is for a plant to do. It is true that the young papaya could become a large and an old plant by the work of its stems and its roots and its leaves alone, but there is another very important work which the papaya must do before it dies. The work of the roots and the stems and the leaves is not enough. There is the work of the flowers and the fruit and the seeds yet to be done. The work of roots, stems, and leaves is simply the work of living and is called nutrition. The work of the flowers, fruit, and seeds is the work of producing new papaya-plants, and is called the work of reproduction. Plants die and plants are born just like animals. Each plant before it dies must produce other young plants, or soon there would be none left in the world.

Now you must learn how the papaya produces its young. You have already learned that the young papayas come from seeds, but you have not learned how the seeds are produced. You may learn this by studying the flowers of papaya, for it is the work of the flowers to produce the fruit and the seeds. The papaya is a good plant to show you the work of flowers, because it has two kinds of flowers. One kind does part of the work and the other kind does the other part. Each kind of flower is quite simple.

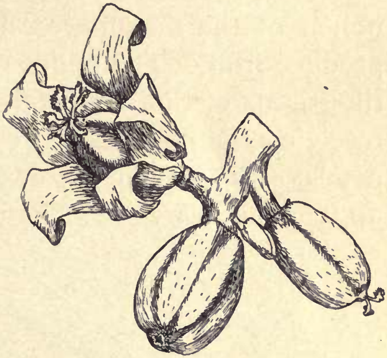
Flower of the man-papaya.

First look at the flowers of the man-papaya. They are much smaller than the flowers of the woman-papaya and there are many more of them. On the outside you find five white parts which are like simple little leaves. These five white little leaves form a part of the flower which is called the corolla. Each of the little leaves is called a petal. In the lower part of the flower the petals are united in the form of a tube. Now if you look in the center of a ripe man-flower you will find at the top of this tube several small yellow parts. You can see these yellow parts better if you take a sharp knife and split the tube. Then by looking carefully you will find that there are ten of these small yellow parts. There are five in a ring on the outside and five in a ring on the inside. The outer ones are just twice as long as the

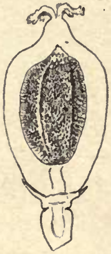

Flower of the man-papaya cut open to show the stamens.

inner ones. These small yellow parts of the man-flower are called stamens. You can see the stamens very well in the picture of the man-flower.

In the tops of the stamens, when they are ripe, you can find a little yellow powder, finer than dust. This yellow powder is called pollen. It is the work of the man-flowers to produce this pollen. You will learn what the pollen is for when you study the woman-flower.


Flower and young fruit of the woman-papaya.

The woman-flower is much larger. It, too, has five petals, but each one is six or seven times as large as a petal of a man-flower, and they are not joined together at the bottom. It is in the center of the woman-flower that we find the most important part. This part is called the pistil. At the top of the pistil there are five short branches and each of these little branches is branched again. Can you see this part of the pistil in the picture of the woman-flower? It is called the stigma. Below the stigma we find a much larger part which is nearly round. If you cut this part open you will find inside of it the very young seeds. This round part is called the ovary and the very young seeds are called ovules. The ovary becomes the fruit. Can you find an ovary in the man-flowers?


Ovary cut open, showing stigma at the top and very young seed within.

Suppose there were no man-papaya plants. Do you think that the ovary would become a ripe fruit with good seeds inside of it? If the ovary can become a good fruit without the help of the man-flowers, then what are the man-flowers for? But we find that if there were no man-papaya trees there could be no good fruit and seed. The man-papaya is very important in helping make the fruit and seed.

Now you can understand the purpose of the pollen. The pollen of the man-flowers is necessary to help the woman-flowers produce fruit. The pollen must be brought from the man-flowers to the stigma of the woman-flowers. The stigma is for the purpose of receiving the pollen. After the pollen has reached the stigma, the petals of the woman-flower fall off, and presently the stigma withers up, but the ovary grows larger and larger until at last it becomes the ripe fruit of papaya. In this ripe fruit are many hundred seeds, each one of which can produce a new plant if it falls in a good place.

Flower branch of man-papaya, bearing small fruit at the end.

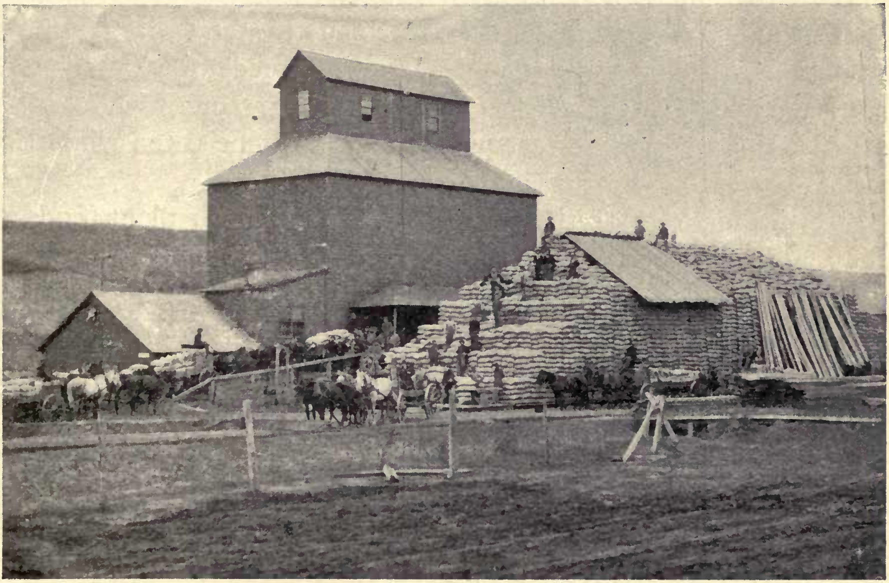
You have learned that the pollen must be brought from the man-flower to the woman-flower. But you have not learned how this is done. Can you think how the pollen may be brought from one flower to another?

You will learn in another lesson how this is done. You will learn that there are little messengers that carry pollen from one flower to another. You will learn that the petals are for the purpose of attracting these messengers. You will learn that these are not messengers for papaya alone, but for many hundreds of other flowers. Nearly all flowering plants must have pollen carried from one flower to another before good fruit and good seeds are produced.

CHAPTER V

THE USES OF PLANTS TO MAN

The first and most important use of plants to man is for food. Probably no country has more kinds of plants which are used for food than the Philippine Islands. Do you think you could write a list of all the plants which the Filipino people use for food? Almost any Filipino boy or girl can think of more than a hundred kinds of plants which are used for food.



Loading sacks of flour in Oregon.

There are many different ways in which the parts of a plant are used for food. Some parts must be cooked before they are eaten; other parts may be eaten without cooking. In some food-plants we eat only the seeds, in others we eat the entire fruit, and in a few we eat the leaves as well.

Rice and wheat and corn, or maize, are called cereals. The cereals form the most important group of food-plants in the world. We eat only the seeds of cereals and they need to be cooked. In countries of the temperate regions, like the United States, wheat is the most important food-plant. The seeds of wheat are ground into a fine powder called flour, and from this flour bread is made. Flour is sometimes made from corn and rice in the same way. One of the reasons why food which comes from the seeds of plants is especially valuable is that it may be kept for a long time without spoiling, if it is kept dry. Other plant-foods must be eaten while they are fresh.

In the markets of the United States the fresh plant-foods are called either "fruits" or "vegetables." Sweet plant-foods which are eaten without cooking are called "fruit." The banana, the orange, the chico, the mango, and the lansones are examples of common Philippine "fruit." But in Nature Study we use the word fruit to describe that part of the plant which contains the seeds, no matter whether it is sweet and can be eaten raw or not.

Rice, potatoes, and maize are common examples of Philippine vegetables. They need to be cooked before they are eaten. In Nature Study should we call the potato a fruit? Do cucumbers and tomatoes contain seed?

Plants are even more important to animals as food than they are to man. Since animals, especially horses and cattle, are valuable to man, the plants which supply food for these animals may often be sold for a good price. In the United States one of the most valuable crops which the farmer produces is the crop of hay or dried grass which the horses and cattle eat in the winter. He also grows much oats and barley for the horses. He feeds corn to his hogs, and this is a reason why the hogs of the United States are very much better than the hogs of the Philippine Islands.

Irrigation of sugar-beets.

Land that is covered with grass which is good food for horses and cattle is called grazing-land. Much money is to be made by keeping cattle and horses on good grazing-land and driving them to market when they are ready to be sold. In the

Philippine Islands there are many square miles of fine grazing-land, but very few cattle and horses are kept on it.

Food is the most important product of plants, and the second in importance is timber. Think of the hundred uses of timber! It is used in building houses, ships, wagons, bridges, railroads, and many other very important things. Now we already know that no country in the world can produce better food-plants than the Philippine Islands. If the same thing is true of timber-plants then the Islands are fortunate indeed! And this is true. Many of the

The timber industry.

finest kinds of timber in the world are to be found here. Millions of acres are covered with fine and valuable trees.

Nearly all of this land is owned by the Government and good care is taken that the fine timber is not wasted, but that it is cut down only as fast as it grows up. In many countries where timber is valuable the trees have been cut down so rapidly that now there is very little forest left. It is just as necessary not to be wasteful in harvesting the crop of the forest as it is in harvesting the crop of the fields.

There are many forest-crops besides timber which are valuable. Rubber and gutta-percha trees are found in the forests of the Philippines. Gutta-percha is necessary in the manufacture of submarine cables and sells for a high price. Like rubber, it is made from a milky juice which comes out of the trunks of the trees when they are cut. Valuable gums and resins are also found in the trunks of certain kinds of Philippine trees.

Gathering flax for linen manufacture.

There are two plant-products in the Islands which are not used for food or for timber. They are the products for which the Islands are best known. Both of them are made from the leaves of plants. These plant-products are hemp and tobacco.

Another class of plants which is very useful to man is formed by those plants from whose fibers cloth is made. The most important of this class of plants is cotton. The best cotton is grown in the southern part of the United States. Some cotton is grown in northern Luzon and it could be grown in many other parts of the Islands. Silk and woolen cloths are animal products. Do you know from what plants jusi and piña are made?

A fourth use of plants to man is their use for medicine. Nearly all medicines are made from plants, and the science of plant-study, or botany, was begun by men who were searching for plant-products which would be valuable for medicine.

We may say, then, that the four great uses of plants to man are for food, for shelter, for clothing, and for medicine.

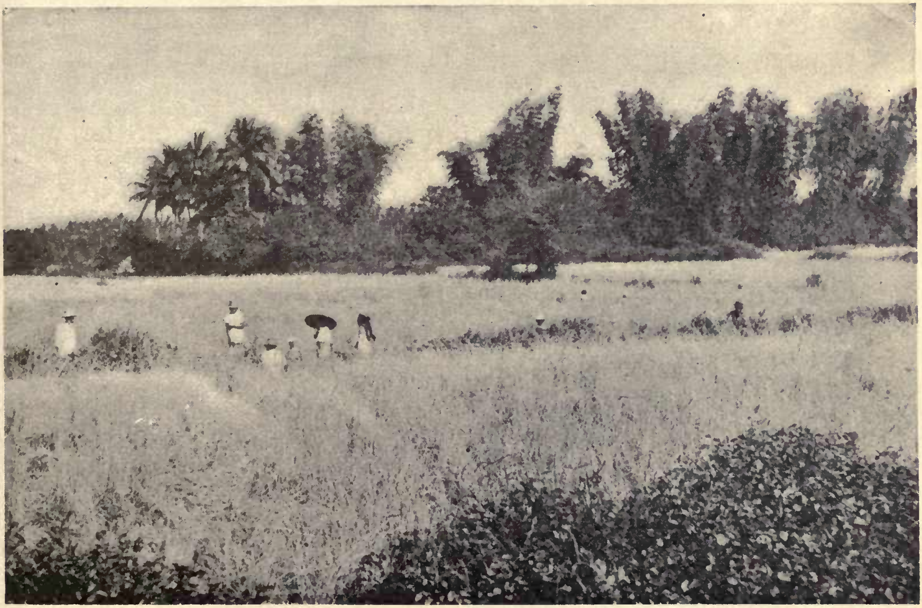
CHAPTER VI

THE USEFUL PLANTS OF THE PHILIPPINE ISLANDS

No country in the world can produce more valuable and useful plants than the Philippine Islands. In many other countries, however, the farmers have learned much more about the cultivation of plants than have the Filipino farmers and so have made their crops more valuable.

This should not be so any longer. The farmers of the Philippine Islands should be as good as their land. Since there is no finer farming-land than may be found here, there should be no better farmers than the Filipino farmers. This may be so in a few years if the Filipino people learn about the useful plants of their country and cultivate them in the best way.

Which is the most useful and valuable plant in the Philippine Islands? Probably every Filipino boy or girl would answer this question by saying that rice is the most useful plant to the Filipino people. Certainly rice is of more use to more people than any other plant. Many of the valuable plants of the Islands might die and most of the people would not be the worse for it, but when the rice



A rice-field.

dies there is much suffering and hunger. The rice-plant should be studied carefully to learn how best to cultivate it and make sure of a good crop.

It has been necessary in recent years for the Filipino people to buy much of their rice from other countries. Many shiploads have come from China. This should not be so. There is plenty of good rice-land and the Filipino people should produce enough rice for themselves and much to ship to other countries besides.

Next to rice, bamboo is perhaps the most useful plant. The first thing a man needs is food. The next thing is a house to give him shelter. Most of the Filipino people live in houses built of bamboo and covered with a roof made of the leaves of the nipa-palm. Bamboo is not only useful in the building of houses, but has very many other uses. What are some of the other uses of bamboo?

There are many important food-plants in the Islands besides rice. Corn or maize and potatoes are important, although they grow better in other countries. In some parts of the Islands corn is used by the people even more than rice.

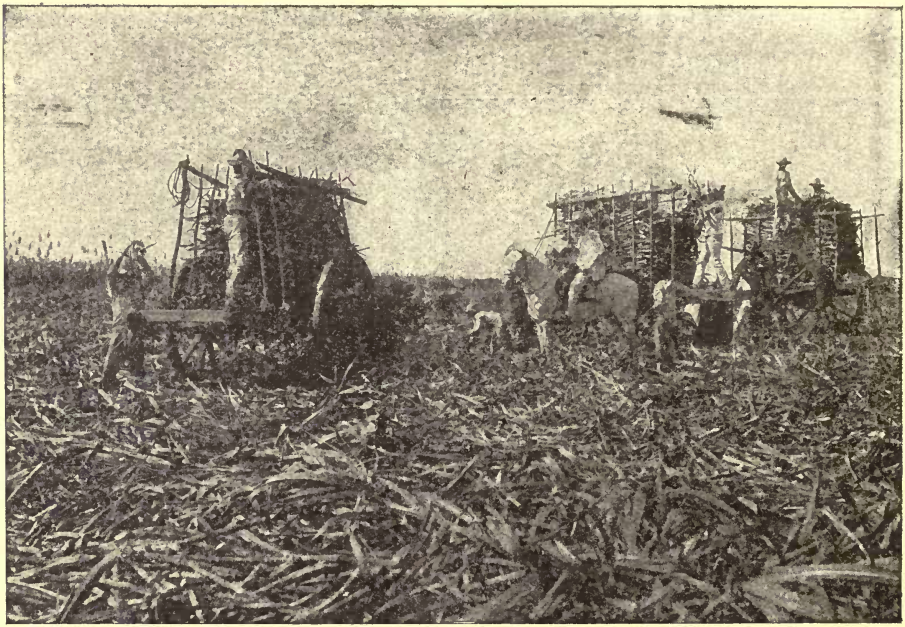
In no country are more kinds of sweet fruits to be found. Philippine mangoes are the best in the world. Everywhere bananas grow and there are more than twenty different kinds. How many do you know? Lansones, chico, atis, and mangostin are delicious Philippine fruits. Have you eaten all of these? Which do you like best? None of these can be grown in the United States, but the oranges of California and Florida are much better than those which grow in the Philippine Islands. This is because much care has been taken in the cultivation of oranges in America. The Philippine oranges may be much improved by cultivation.

The plants which you have just read about are those which are most important to the Filipino people for their own use. There are others, however, which are more important than these for the purpose of export. Products which are sent to other countries are called exports. The most important plants whose products are exported from the Philippine Islands are abacá, niog or coconut, tobacco, and sugar-cane.

Abacá produces the famous Manila hemp from which the best rope in the world is made. No other country can grow this wonderful plant so well as it grows in the Philippine Islands. There is always a strong demand in the markets of the world for Manila hemp. More of it could be produced without causing the price to decrease. It is one of the crops which the Filipino farmer should cultivate more than he does to-day. The only danger of reducing the good prices now paid for Philippine hemp comes from mixing bad fibers with good ones. That has been done by some dishonest dealers in hemp. To do such a thing is to injure the whole Filipino people, for if it is found that Philippine hemp is not always reliable and good the price for it will become much lower.

A field of abacá.

The coconut is very important both for home or "domestic" use, and for export to foreign countries. Caña and niog, or bamboo and coconut, as we say in English, are the two plants which have a hundred different uses. The coconut-palm is perhaps better known to the people of temperate regions than any other tropical plant, for dried coconut is sold all over the world. What are four different and valuable plant-products which come from the coconut?



Gathering sugar-cane.

Much fine tobacco is grown in the islands of the West Indies, especially in Cuba. This is a crop which can also be grown in the United States, but not so well as in the tropics. The islands of

Cuba, Sumatra, and Luzon are the best tobacco-producing countries in the world. In Cuba and Sumatra more study and care has been given to the cultivation of tobacco than in the Philippines, but there is no reason why Luzon should not produce as fine tobacco as any in the world if it is carefully cultivated.

The islands of the Visayan group have fine land for the growing of sugar-cane. This is another of the Philippine crops which may be much improved by the use of better methods.

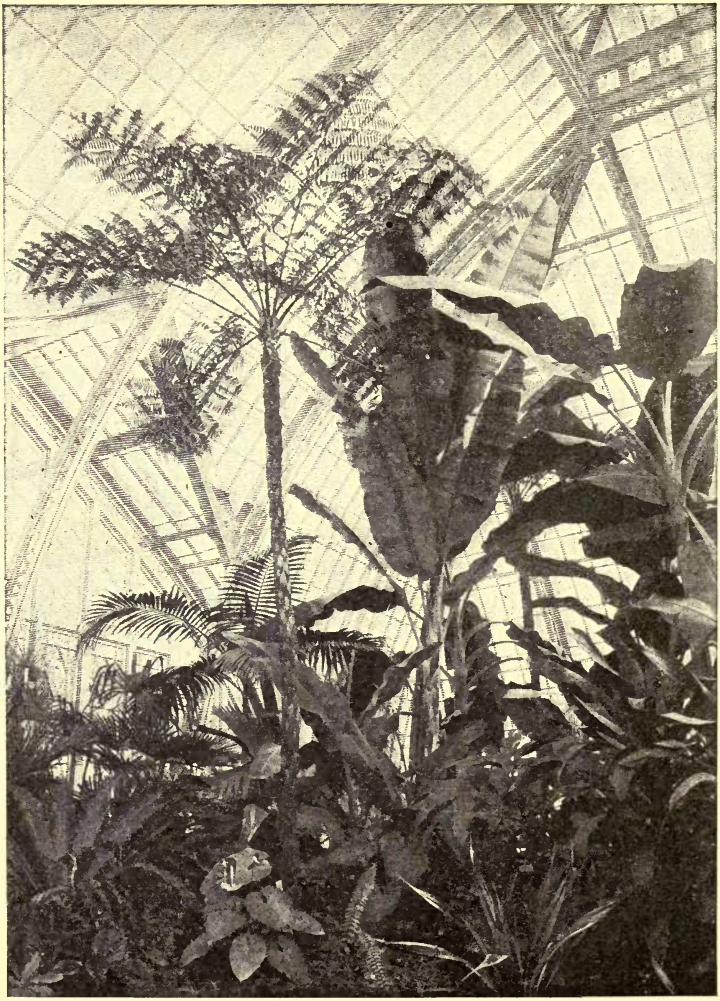
These are but a few of the many plants which make up the wonderful abundance of plant-wealth with which the Philippine Islands are blessed. We must remember the rich forest-crops which grow wild. We must remember the cacao, the coffee, the cotton, the piña, and the ilang-ilang which will all bring wealth to the farmer who cultivates them carefully.

So it is easy to understand why Filipino boys and girls should learn all they can about the plants of their beautiful Islands. The wealth of the people will always come from the products of the plants, and the value of these products is increased many times when we understand how the plants grow and cultivate them in the best way.

CHAPTER VII

THE BANANA

It would be hard to find Filipino boys and girls who could not tell the name of a banana as soon as they saw its big leaves. Bananas grow everywhere in the tropics, and the fruit is sent to all parts of the temperate regions. Although children who live where there is ice and snow in winter may have many bananas to eat, they probably would not know a banana-plant when they saw it unless the



Banana-plants growing in a conservatory with other tropical plants.

ripe fruit was hanging from it. No plants which grow in the temperate regions have such huge leaves as the banana-plant. In the United States bananas are sometimes grown in glass houses where the air is kept warm all the time. These glass houses are called conservatories. They are built of glass so that there may be plenty of light. Why is it necessary for plants to have plenty of light?

The bananas which are sent from warm countries to be eaten in cold countries are picked while they are still green. If they were picked when they are ripe they would decay long before reaching their destination. The green bananas ripen slowly in America if they are kept in a warm place. You very often see men with little carts going about in the cities of America selling bananas which have come a thousand miles from the south. Some ships come to the United States loaded with nothing but bananas. Thousands of bunches are sent in trains to all parts of the country. Those sent from Central America to the United States are larger than Philippine bananas, but they do not have so pleasant a taste as when they are allowed to become nearly ripe on the trees.

There are more different kinds of bananas in the Philippines than are ever seen in America. Can you tell your teacher the names of ten different kinds? Which kind do you think is best to eat? Here is a picture of the butuhan. The butuhan is not good for eating but is the most common kind. Why is it not good for eating? Many people are very fond of the lacatan. Is lacatan cultivated or wild? Does the butuhan grow wild? We may call the butuhan the most successful kind because it is the most common.

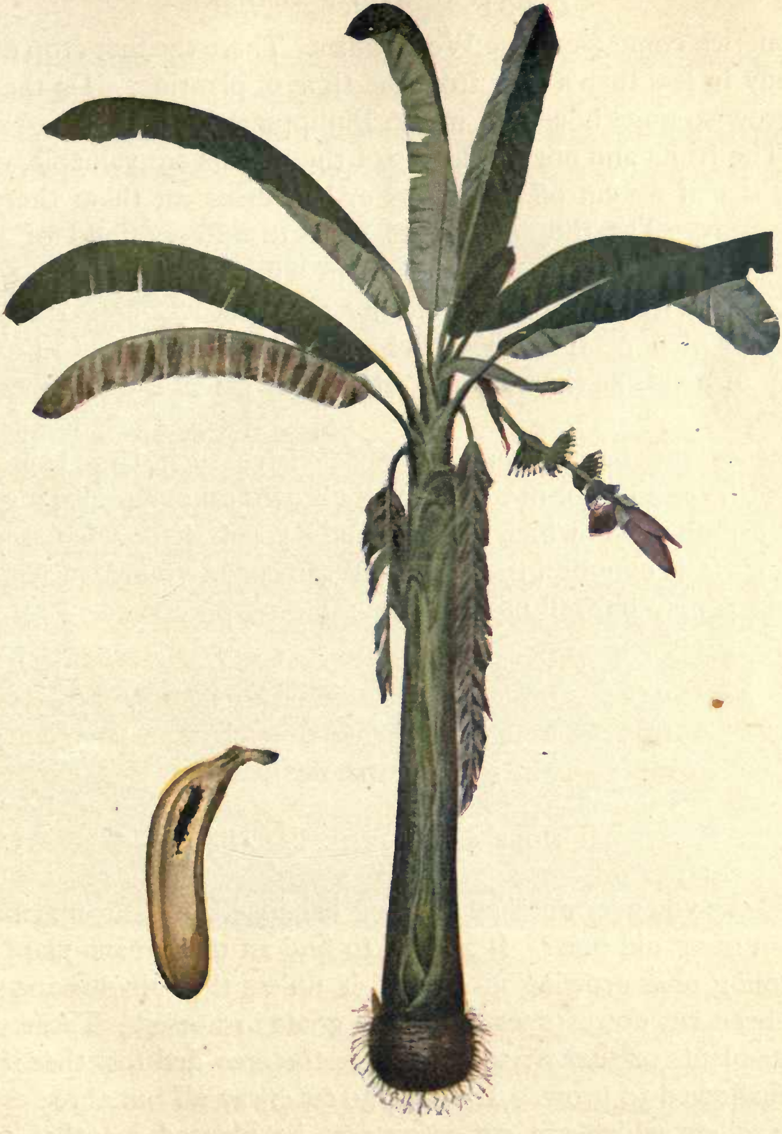
How many different parts are there in a banana-plant? In the picture you can see the stem and the big leaves and the flower-part and some of the fruit. What is the part which you can not see in the picture?

The leaf is so very large that you can easily see its different parts. In the center is a strong, stiff part called the midrib. It is like a strong bone in the body of the leaf and holds it up so that it can do its work. From the midrib, other ribs run out to the edge of the leaf. These smaller ribs are called the veins of the leaf. In the leaf of banana the veins all have the same direction. They run straight from the center to the edge of the leaf. Did you notice the veins of the leaf of papaya? Are they all in the same direction?

Since the veins of a banana-leaf all run the same way it is easy to tear the leaf that way, but very difficult to tear it the other way, across the veins. Nearly all the old leaves of banana are torn into strips by the wind. It does not kill the banana-leaves to be torn in this way. They seem to do their work just as well as before, but if you cut a banana-leaf across the veins, it will soon die. This is because the veins, besides giving strength to the leaf, are for the purpose of carrying to its different parts the materials necessary for its work. What other part of the plant receives the materials which are necessary for the work of the leaf? The veins also carry back into the stem of the plant the food which is manufactured in the leaves.

The banana, like the papaya, grows up very rapidly. It does not grow up from seeds, but has an underground part of the stem which sends up side-shoots or suckers. These suckers may be cut away and planted in other places. When the big leaves of the sucker begin to unfold they grow very fast. Sometimes a leaf grows several inches in one day. First there is a long, green roll, formed of two leaves. When these unroll other leaves appear, and thus the beautiful, spreading crown is formed. The stem is formed of the leaf-stalks or petioles which are rolled one over the other.

Do you know how long it takes a banana-plant to grow up from the sucker and produce fruit? Most of the bananas which are eaten



Lacatan.

in America come from the West Indies. There the first crop of fruit is ready in less than a year from the time of planting. Do the bananas grow so quickly as that in the Philippines?

The fruits and not the leaves of the banana are valuable, yet we know that if we cut off the leaves or let horses eat them there will be no fruit. The Filipino horses seem to be very fond of young banana-leaves. There is another plant which is much like the banana, whose fruit is not valuable but whose leaves are. Have you seen this plant? It is the abacá. The abacá belongs to the same family of plants as the banana. It may be called the cousin of the banana.

Since the banana and the abacá have such large, spreading leaves they are useful not only for their own sake, but also to shelter other useful plants which need a good deal of shade when they are young. It is common to use bananas to shade young cacao-plants, and abacá may be well used for the same purpose.

CHAPTER VIII

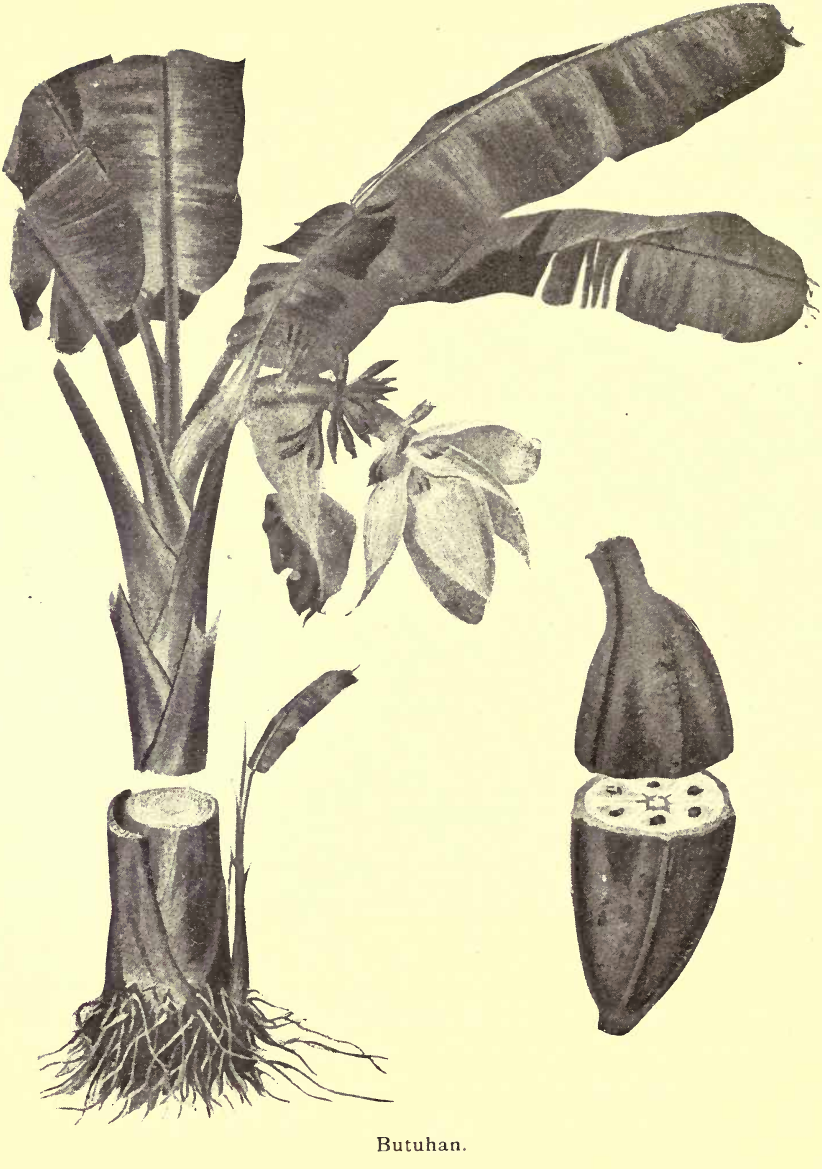
MORE ABOUT THE BANANA

HAVE you ever watched a young banana-plant grow up from the bottom of an old one? It is hard to find an old banana-plant without young ones growing up around it, unless the baby banana-plants have been cut down or eaten by the goats or horses. These young banana-plants or suckers soon become too crowded together if they are all allowed to grow. It is best to cut away all but three or four. The suckers which are cut away may be planted in other places.

Since the large leaves need plenty of room, the suckers should be planted about twelve or fourteen feet apart.

The banana is one of the easiest plants to cultivate and one of the most productive. The best bananas are grown where the soil is deep and has plenty of the decayed parts of plants in it. The decayed parts of plants supply rich food-material for the roots of living plants. Do you know about how long one banana-plant can live? Do you know how many bunches of bananas one plant can produce?

A banana-plantation.

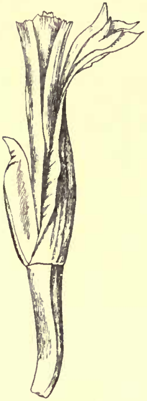


Butuhan.

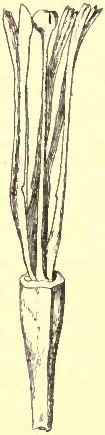
You know that papaya-plants grow up from seeds and that banana-plants grow up from suckers. Do you know whether banana-plants ever produce good seeds? Can you see the seeds in the fruit of lacatan? You can see them easily in the fruit of butuhan, but do you think that these seeds are able to produce new plants? It is easy to understand that if the seeds of banana were good for producing new plants the fruit would not be so good to eat. The seeds of lacatan are so small and weak that we eat them without noticing them.

Is it better for a plant to produce its young by means of seeds or by means of suckers? This is a rather difficult question to answer, but we can certainly see that the seed-method is better in some ways than the sucker-method. Seeds are often carried by the birds or by the wind far away from the parent-plant and grow up where there is plenty of room. Unless men transplant them, the suckers must grow up very near the old plants, and many of them die from being crowded too closely together. When plants are crowded too closely together there is not enough food-material for all the roots and not enough light for all the leaves.

Now let us look at the flower-part of the banana. The flowers of bananas are all a good deal alike, but perhaps you will find those of butuhan the easiest to get. In the center of the plant we find a large red part which has something of the shape of a heart. Is this part a single flower or is it composed of many flowers? We shall have to open it to be sure. On the outside we find dark-red leaves. Beneath each of these stiff leaves a row of yellow or white flowers is to be found. So we may be sure that the large, red part is not a single flower, but is composed of many flowers separated by the red leaves. Such a group of flowers is called an inflorescence, and the red leaves are called bracts. The pink flowers of cadena d'amor and the man-flowers of papaya are also arranged in inflorescences, though not so close together as the flowers of banana. The flowers of the palm-trees are also arranged in inflorescences. Have you ever eaten a young inflorescence of banana? It is good to eat when cooked.

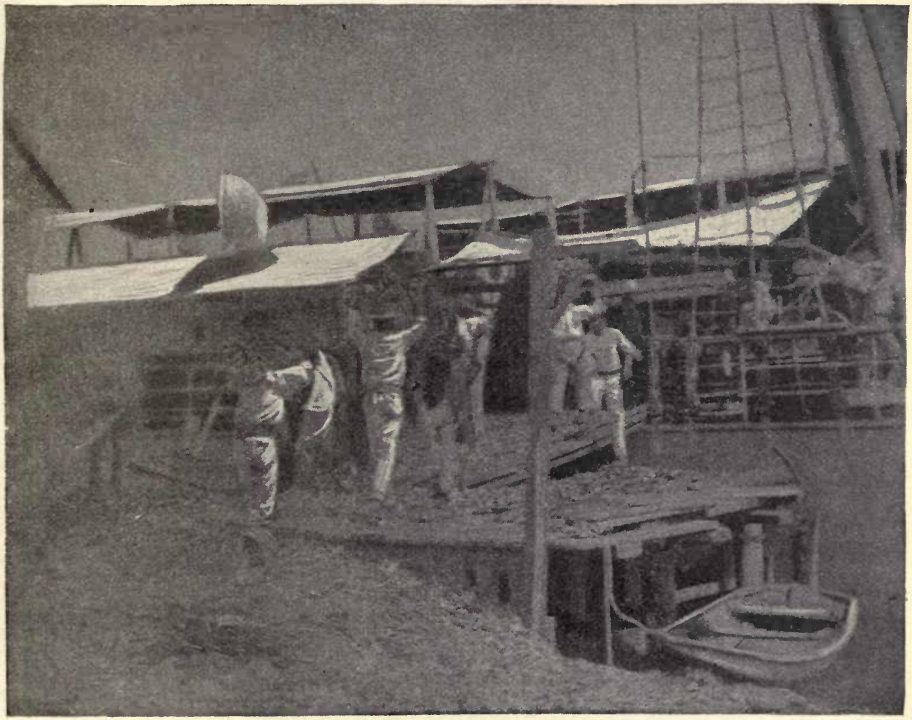

The flower of butuhan.

Under the first red bract we find flowers which are about two inches long. The flowers under the next bracts are a little shorter, and if you pull off the bracts one at a time you can at last find flowers which are less than one inch long. You can see very plainly how the lower part of the flower slowly changes into the fruit. You learned from papaya that this part of the flower is called the ovary. You should make six or seven pencil-pictures of banana-flowers, beginning with the youngest and finishing with the fruit itself.


The flower of butuhan, with petals removed.

The fruit is formed from the lower part.

You will notice many differences between the flowers of banana and those of papaya. In the first place, the banana has only one kind of flower while the papaya has two. For this reason all the flower-parts of banana must be in the same flower. The corolla of papaya has a regular shape, like a wheel. The corolla of banana is irregular. Then in the woman-flower of papaya the petals are fastened below the ovary. In banana the petals are fastened above the ovary. The petals of banana are not separate like those of woman-papaya. They are united in a long tube, which spreads open when the flower is ripe. At the top of the corolla you may see five large stamens. Inside of these stamens you find a swollen part, like the knob on the end of a cane. This is the stigma. You remember that the stigma of papaya is divided into branches and is closely fastened to the top of the ovary. Since the ovary of banana is below the petals there is a long, slender part to connect the stigma with the ovary. You can see this part when you cut the flower open. It is called the style. Nearly all flowers have styles, so that we say the pistil is composed of ovary, style, and stigma.



Loading a ship with bananas.

Now that the flower is cut open you can see the stamens very plainly. How many are there? Are they fastened to the corolla or to the bottom of the flower? Can you find any pollen?

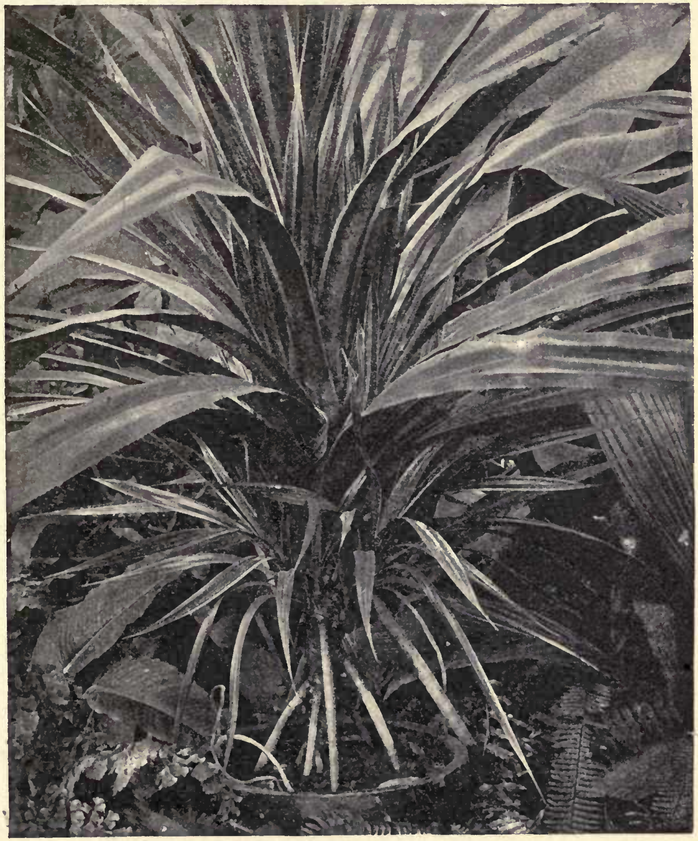
There is still another very important difference between the flowers of banana and the flowers of papaya. You learned that the pollen of papaya is carried from the stamens of one flower to the stigma of another. You learned that this transfer of pollen occurs in most flowers even though stamens and stigma are to be found in the same flower. You learned that this is necessary in order to make good seed. Now in banana the pollen is not transferred from one flower to another. This is one of the reasons why the banana does not have good seed and must produce its young by means of suckers. When you open the banana-flower you can see that the stigma is covered with pollen from the stamens of the same flower. The pollen-bearing parts of the stamens, which are called "anthers," grow very close to the end of the pistil, so that the pollen is sure to reach it.

CHAPTER IX

PANDAN; A SHORE-LOVER

The pandan is a peculiar plant, common along the shores of all tropical countries. You can find it in nearly all parts of the Philippine Islands. The only important use of pandan to the Filipino people is the use of the leaves for making mats. Can you explain how this is done?

You may know pandan by its strange roots. These roots are as much in the air as they are in the ground. Because they seem to



A small pandan, showing the prop-roots.

prop the plant up, they are called prop-roots. You can often find roots of pandan which have begun to grow down from the stem, but which have not yet reached the ground. At the end of these roots the "root-cap" is always to be found. If you pull off this cap the tender, growing end is found beneath. The root-cap is always found at the end of growing roots, but in very few plants is it so easy to examine as in pandan. Usually it is deep under the ground and comes off when we pull the plant up. The root-cap is very necessary when the root is growing in the soil, pushing its way deeper and deeper. Without it, the tender tip would soon be bruised and injured. Of course the cap is not so useful while the end of the root is in the air, yet its presence proves that the part we are examining is not a branch of the stem. It is a true root, trying to reach the soil. Protecting caps are not so necessary for the growing ends of stems and branches. Of course it is much easier to grow in the air than in the ground. Besides, the tender tips of stems and branches are protected by the young leaves which curve over the end. Roots never have leaves.

The leaves of pandan are also peculiar. They are hard and tough and have stiff points along the edges. It is hard to pull them without scratching the hands. They are long and narrow, and, when young, they point straight upward. When they are older they bend in the middle and the outer end droops toward the ground.

Now we know that every part of a plant is usually for some purpose. Do you think we can tell the purpose of the prop-roots and the hard, stiff leaves of pandan with their peculiar shape and position? Why are they so different from the roots and leaves of nearly all other plants?

If we are to understand the purposes of the parts of a plant we must always think of the place where it lives. We can understand the peculiar parts of pandan better if we remember that it lives most commonly along the shores. It may be called a "shore-lover."

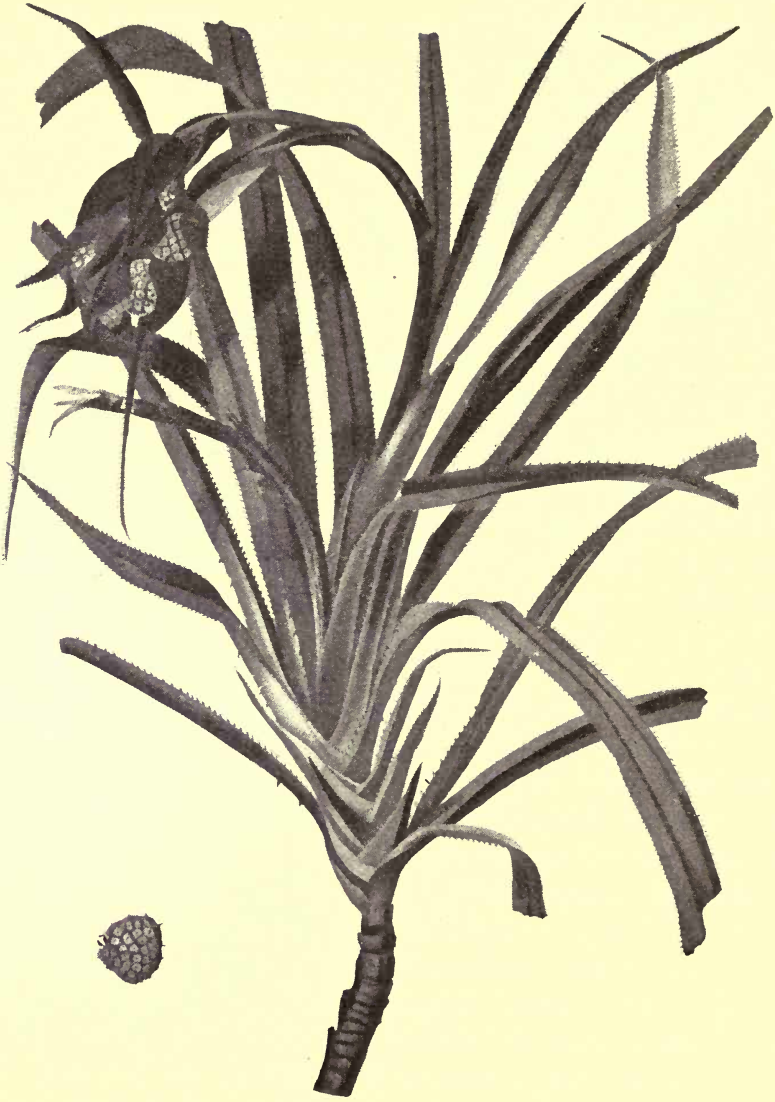
Now you know that along the shores of the Philippine Islands many plants are killed every year by the salt water which is blown in from the ocean by the typhoons. Along the Luneta, which borders the shore of Manila Bay at Manila, no plants can be grown except those which have hard, tough leaves which will not be killed by the driven spray. Salt water is much worse for plants than the fresh water which strikes them as rain, however hard the rain may be driven by the wind. The salt kills tender leaves. So if a plant is a shore-lover it must have hard, tough leaves like those of pandan.

The shape and position of the leaves, as well as their toughness, help pandan in its life on the shores. They are long and narrow and may be whipped in the wind without being torn. Their veins run in the same direction. Their sharp points or spines keep them from being eaten by animals.

Along the shore there is very little shade. Shore-lovers have the heat and light of the sun on them all day long. You know that green plants must have light, yet they may get too much, both of light and heat, unless their leaves are somewhat like the leaves of pandan. The leaves of pandan point either toward the sun or toward the ground. So in midday, when the sun is brightest and the heat is greatest, they do not get so much light and heat as if their broad sides were toward the sun. The rays of the sun at midday do not shine straight upon them, but at an angle. This is another thing which helps pandan to live where other plants would quickly die.

Now can we explain the strange roots of pandan? Does it have roots which are half in the ground and half in the air because it is a shore-lover? This is not an easy question to answer. We think that the prop-roots of pandan may be due to the tides, yet of course pandan often lives and has prop-roots where the tides never reach them. Do you know what tides are? Do you know what tide-marks are?

For boys and girls who live along the shores these are very easy questions. They know that the water goes out at some times and comes back at other times. These changes of water are called the tides. When the water comes up high on the land it is called high-tide. When it goes out it is called low-tide. There is a low-tide mark and a high-tide mark. As you walk along the shore it is very easy to see the high-tide mark. It is shown by the mud which is left



Pandan.

by the water when the tide goes out. Now it is very common for the pandan to grow between the tide-marks. When it is low-tide the prop-roots are exposed to the air, but when it is high-tide they are covered with water and can do the natural work of roots. So this arrangement of the roots seems to help the pandan live between the tide-marks.

There is one other very important reason why the pandan is a shore-lover. It is because its peculiar fruits are scattered by the waters of the sea. They float in the salt water and may be carried great distances without being injured. At last they are washed high up on the shore by the waves in some storm, and there they soon form young pandan-plants. As you walk along the shores it is very common to find pieces of pandan-fruit washed up by the waves, perhaps half buried in the sand. It is a compound fruit. That is, the fruit is not formed from a single flower, but is formed from the whole inflorescence of female flowers. Each of the small parts of the fruit of pandan contains a seed. It does not injure them to be buried in the sand. It is a sort of natural planting.

CHAPTER X

PANDAN; A WIND-LOVER

The fruit of pandan is not to be found at all times of the year, like the fruit of papaya or banana. You may have some trouble in finding it, but, when you do, you will see that it looks a good deal like the fruit of piña. The leaves of pandan and piña also look much alike. In America the fruit of piña is called pineapple, but in England and the English colonies it is usually called pine. For this reason the pandan has been called by the English "screw-pine," although pandan and piña are not closely related like banana and abacá. There is another group of plants, very different from both the pandan and piña, which are also called pines. These pines are tall trees which are common in temperate regions, but rare in the tropics, except in the mountains. In the Philippine Islands they are to be found in the mountains of Benguet and Zambales provinces. The leaves of pine-trees are hard and are shaped like needles. They remain on the tree all winter long, no matter how much snow and ice there may be. Pine-trees furnish one of the most useful kinds of timber in the world.

Although the pandan or screw-pine and the true pines are very different plants in nearly every way, in one important thing they are alike. They both use the wind for the transfer of the pollen from one flower to another. For this reason they are both called wind-lovers. Like papaya, pandan has two kinds of flowers. The male flowers produce pollen; the female flowers produce fruit. Yet the flowers of pandan do not look at all like those of papaya. They do not have bright-colored petals or pleasant odors. Indeed, you might think

Flowers of the man-pandan.

Stamens from man-pandan.

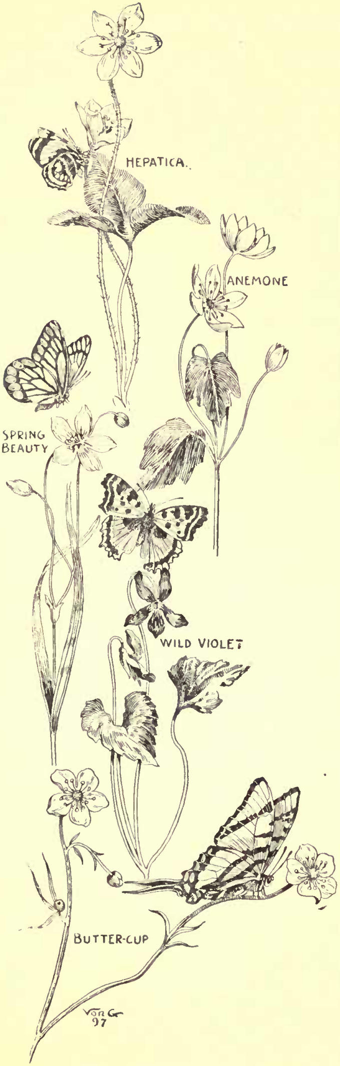
at first that they are not flowers at all, but since they produce either pollen or fruit we know that they must be flowers, however strange their appearance may be. They are arranged in close inflorescences, like the flowers of banana. The male flowers are composed of nothing but the many small, white stamens. The female flowers are composed of nothing but the pistils. They may be called naked flowers.

Now it is time for you to understand why most flowers are not naked, but are clothed with bright corollas and have pleasant odors. You can understand the purpose of these parts best by comparing them with flowers like those of pandan which do not have these parts.

You learned from papaya that the pollen must be transferred from the stamens of one flower to the stigma of another, or else good seeds and fruit will not be produced. You learned that the pollen of banana is not transferred from one flower to another, and bananas do not produce good seed. Now if you watch bright-colored flowers on sunny days you will see that they are often visited by bees and butterflies and other insects. These insects fly from flower to flower seeking the sweet honey or nectar which is to be found in the corollas. You might think that the insects are enemies of the flowers, since they rob them of their sweet nectar, but the truth is that they are among the best friends which the flower has. The flowers are very glad of their visits. The bright colors and pleasant odors are for the very purpose of attracting these insects so that they will come to the flowers. The sweet nectar is a food of which they are very fond. The flowers are glad to give it to them in payment for their visits.

Why? Because these insects are the special messengers which carry the pollen from one flower to another. Because, while the insects are getting the nectar, some of the pollen is sure to stick to their bodies, and when they go to the next flower it is rubbed off on the rough or sticky surface of the stigma. Now you can understand why many flowers are clothed with bright corollas and have pleasant odors. Such flowers may be called insect-lovers. Now, too, you can understand why the flowers of wind-lovers, like pandan, are naked. Bright colors and pleasant odors would not attract the wind. The wind goes to all parts of the plant alike. Many kinds of trees in the Philippine forests, whose flowers are borne high up where the wind is sure to strike them, are wind-lovers.

Is it better for a plant to be a wind-lover or an insect-lover? We may see that each way has some advantages over the other. If a plant is a wind-lover it does not have to make bright-colored petals to attract the insects, or sweet nectar for them to eat. When a plant has these things it means that the stems and roots and leaves have had a great deal of work to do in making them. A plant which is a wind-lover saves all this work. You must remember that flowers and fruit are produced by the work of the roots and leaves, and those plants are most success-



Butterflies visiting flowers to carry away pollen and nectar.

ful which produce good fruit and many seeds with the least amount of work. So you may think it is better for a plant to be a wind-lover than an insect-lover, since much work is saved by this method. Yet we must remember that the wind is not so safe a messenger as the insects. It will not blow the pollen straight from the anthers to the stigmas. For every grain of pollen which safely reaches the stigma perhaps thousands of others are blown to other places. For this reason wind-lovers must produce very much more pollen than insect-lovers. For this reason you find in the inflorescences of the male flowers of pandan very great quantities of pollen. The inflorescences are composed of thousands of stamens crowded close together. When they are ripe you may shake showers of pollen from them. Perhaps it is almost as hard a task for the plant to make so much pollen as it is to make bright corollas and sweet nectar and only a little pollen. So you see that each way has some advantage over the other and both are good.

CHAPTER XI

THE GUMAMELA

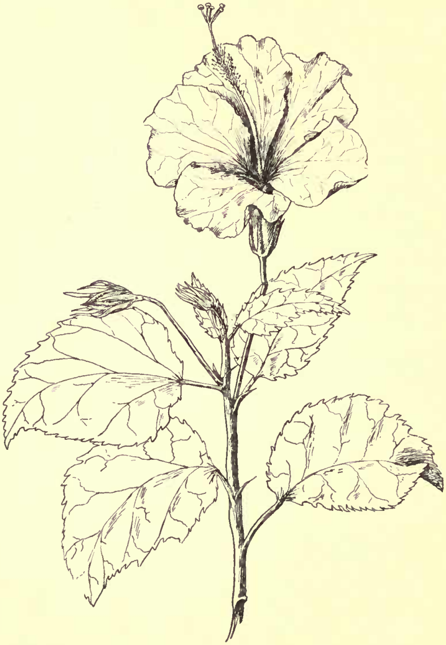
The gumamela is a shrub. All plants may be divided into trees, shrubs, and herbs. The herbs are the low, weak plants which do not grow much higher than your waist. Shrubs or bushes are plants with woody stems which branch a good deal, but do not grow as high as trees. The gumamela is a perfect example of a shrub.

Gumamela is perhaps the commonest garden-flower in the Philippine Islands. It is not cultivated for its use, but for its beauty.

Its large, red flowers can be seen for half a mile. Do you know any other flowers which can be seen from so far away?

The gumamela can be grown in temperate countries, but its flowers are never so large and beautiful as they are in the tropics. In the United States this flower is called hibiscus. Does the gumamela bear flowers all year long? Does it produce good fruit and seed?

If you gather a gumamela-flower and look at it carefully you can very easily see all the different parts. Since the flower is clothed with bright and beautiful petals you may be sure that it is visited by insects. What insects have you ever seen visiting the gumamela? The first thing that we notice in the flower is the corolla. It is composed of five, very large, red petals. Are these petals united like the petals of a banana or are they separate? The banana-flower may be called a closed flower, because its petals are closely united into a tube which hides the stamens and the pistil. But the gumamela has an open flower, and we can see the central parts even more plainly than we did in the papaya. Outside and under the red corolla may be found the small, green part called the calyx. The calyx is composed of five united sepals. Outside the calyx are several small, pointed, green

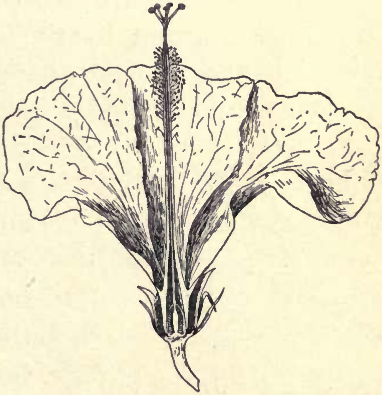


Gumamela.

leaves which are not a proper part of the flower. They are called bracts.

Now if we look at the center of the flower, one, long, slender, red part is seen. At the top it is divided into five branches, each with a dark-red, little knob at the end. These little knobs are the stigmas of gumamela. You know already that the stigma is for the purpose of receiving pollen. Below the five short branches which carry the stigmas many stamens are seen. Each of these stamens has a very slender, little stem which branches out from the main stalk. About how many stamens do you find in one flower?

When the flower is ripe the top part of each little red stamen opens and you may see the bright yellow pollen-grains. Since the pollen-grains of gumamela are much larger than those of other plants, you can see each one with the naked eye if you look very closely. Each stamen produces about fifty or sixty grains of pollen.



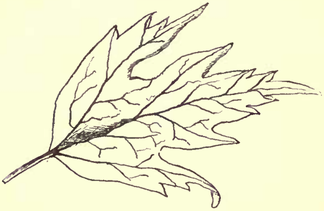
One half of the flower of gumamela.

Now you have found the stamens and the top part of the pistil, but where is that very important part of the flower that bears the young seeds, and after a while forms the fruit? You know that the right place to look for this part is at the bottom of the pistil. You found it there in the female flower of the papaya and in the banana-flower. You know that the name of this part is the ovary. But you can not see the ovary of the gumamela until you cut the flower open. If you first pull off the petals, and then carefully cut open the bottom of the flower, you can find the ovary.

It is covered by the bottom of the long, slender, red part which bears the stamens and the stigma-branches. This part is called the "column."

If you split open the column you will find a long white thread inside of it. This thread connects the stigmas with the ovary. It is called the style. You learned about the style in studying the flowers of the butuhan, but the style of gumamela is very different from that of butuhan because it is covered by the column. This column is really composed of the lower parts of the stamens which are closely united together. You can understand these things much better by looking very carefully at the picture of the gumamela flower cut open.

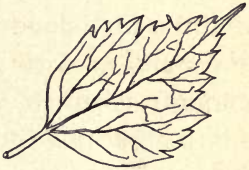
Of course there are very many flowers which do not have a "column" formed by the union of stamens and pistil. In most flowers these parts are separate. Yet there is a great family of plants called "column-bearers" because they have the stamens and pistil united. These plants are common in the Philippines. Malvas and calut-calutan are common examples. The gumamela d'arania is another member of this family which is common in the Philippine gardens. In English this flower would be called the "drooping hibiscus." Its flowers do not seem to have the strength to hold themselves erect like the flowers of the large gumamela. The long, very slender column hangs straight down. The petals are much divided, so that they seem to form a sort of fringe. Are the leaves of the gumamela d'arania different from those of the large-flowered gumamela? You will have to look very carefully to make sure of this, for on



Leaf of gumamela from near the bottom of a branch.

the gumamela it is common to find two kinds of leaves. The leaves at the bottom of the plant are often very different in shape from those at the top.

Neither kind of gumamela produces good fruit and seed. If you want to plant gumamela in the garden how do you do it? If the gumamela does not produce good seed you may wonder what the flowers are for. You have already learned that all parts of a plant have some purpose and that it is the purpose of flowers to produce fruit and seed. Now in the gumamela we have a plant which produces fine flowers, but does not finish the work by ripening the seeds. You can find in the ovary the very young seeds, but they never become mature.



Leaf of gumamela from near the top of a branch.

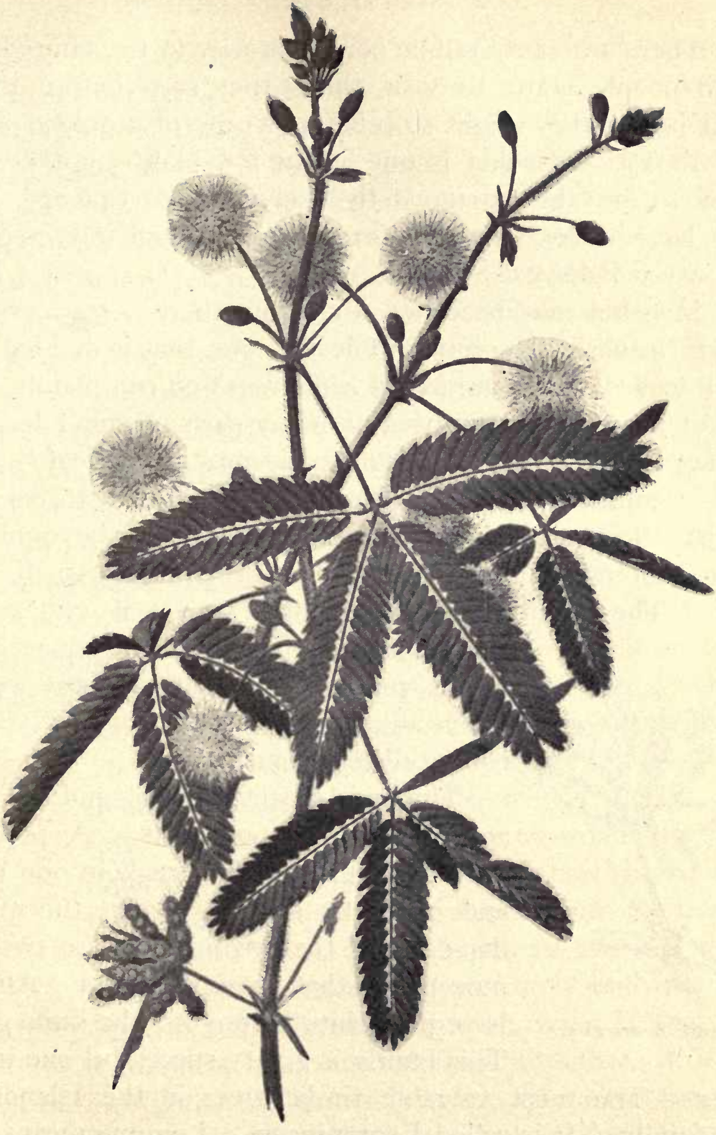
The reason for this is that the gumamela has been cultivated by men for the sake of its flowers and not for the sake of its seeds. Rice is cultivated for its seeds and so it always produces good seeds. But the life of gumamela is made easy for it by keeping away all its enemies, and it is reproduced by cuttings which men make from the old plants. This is not a natural way of reproduction, but it is an easier way for the plant than the seed-method, so the gumamela has gradually lost the power of producing good seed. They are no longer necessary, as they were very many years ago when gumamela was a wild plant. But gumamela still has the habit of making very handsome flowers.

CHAPTER XII

MACAHIA; THE SHAME-PLANT

THIS plant has a very good name. Every boy and girl in the Philippine Islands knows that when the macahia is touched with the hand or with a stick it bends down and closes up its leaves as though ashamed of itself and trying to hide. Although the macahia hangs its head as though in shame when you notice it, it must be a very happy plant if plants are happy when their lives are successful. Few plants in the Philippine Islands are more successful than macahia. It grows everywhere and spreads modestly, but rapidly, crowding out other plants. It produces fresh flowers and fresh fruit every day. Its seeds are very healthy and soon grow into young plants. In tropical countries the macahia is considered a troublesome weed. Plants which are troublesome to the farmer and crowd out the cultivated plants are called weeds. Macahia is one of the enemies of rice, and the rice-paddies must be kept carefully cleared of it, for macahia spreads rapidly when the water stands low on the paddy and crowds out the rice.

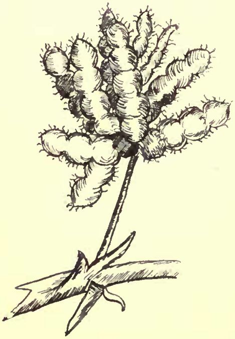
Although macahia is a wild plant in the tropics it is a very carefully cultivated plant in the temperate regions, where it is considered a great curiosity. There it is called the "sensitive plant," because it is so sensitive to the touch. In America the macahia can be grown only in the conservatories because it can not live in cold weather. The glass-roofed conservatories are carefully heated in winter and kept at just the same temperature all the time, so that many tropical plants can be grown in them quite as well as though they were at home.



Macahia.

There are many public conservatories in the United States, and when people come to visit them they stop before the sensitive plant just as they might stop before a cage of monkeys in a museum of animals. Macahia is one of the few plants in the world which seem to be able to move themselves when touched, and people who have never seen it before are very much interested in seeing the way it behaves.

Macahia may be called a creeping herb. Its leaves are compound leaves. A compound leaf is one that is divided into many small leaves, which are called leaflets. You can plainly see that the leaf of macahia is composed of many pairs of small leaflets. How many pairs of leaflets do you usually find in one leaf? The acacia-tree is another common Philippine plant which has compound leaves. The acacia and macahia belong to the same family of plants, though one is a large tree and the other a small and modest herb. They seem to be very different, yet if you compare the flowers and the fruits and the leaves of these two plants you will see that in many ways they are much alike. At least they are near enough alike to be called cousins.



Fruit of macahia.

The fruit of the macahia and the fruit of the acacia are both pod-fruits. A pod is a long, narrow fruit which has seeds in one or two rows and opens by splitting down the middle. The dap-dap and the Spanish flag are two other common plants that have pod-fruits. All plants that have pod-fruits belong to the same great family. This family is a very successful one in the Philippines. The most valuable timber-trees in the Islands belong to this family. It is called Leguminosæ. Legume means pod.

The flowers of macahia are fresh and pretty every morning, but when afternoon comes they have faded in the hot sun. If you want to examine them you must be sure to go out in the morning. Macahia seems to have a round, pink flower, but when you pick it and look closely you will see that this round, pink part is composed of very many small flowers. If you gather macahia flowers before ten o'clock you will find a small white body at the end of each of the slender pink rays which come out from the flowers. These slender pink rays are the stamens and the white bodies at the ends are the anthers which contain the pollen. Now if you want to find the tiny corollas of macahia you will have to pull one of the clusters of flowers apart and look very closely. You learned from banana that a cluster of flowers growing close together as in macahia is called an inflorescence. The flowers of acacia also form an inflorescence.

One flower of macahia.

If you carefully separate the small flowers which form the inflorescence of macahia you will find that the corolla of each tiny flower is not more than an eighth of an inch long. The petals are united. Four stamens and a long, slender pistil seem to come from each flower. The tiny flowers of macahia are crowded so closely together in the inflorescences that there is not room for a pod to be developed from the ovary of each one of them. Perhaps there are fifty flowers in one inflorescence, yet you rarely find more than eight or ten pods in a single cluster. If you watch a macahia inflorescence from the time it is very young until the ripe fruits are formed, you can see how some of the pods seem to get a start on the others and soon crowd them out.

Flower of macahia cut open.

You can do this by very gently tying a piece of thread just behind a young macahia inflorescence so that you will be able to recognize it the next day. How many days do you suppose it takes for the pods to be formed from the inflorescences? You would be surprised to find how quickly this is done. Of course it is the flowers whose stigmas are the first ones to be pollinated which are the ones to get the start in developing the pods. So all the little flowers of macahia are trying to get the pollen on their stigmas as soon as possible. The stigmas are very small, but since all the flowers are very close together some pollen is almost sure to be carried from one flower to another. What insects have you ever seen visiting the flowers of macahia? Do you think it is an insect-lover or a wind-lover?

The pods of macahia have many slender spines upon them. Can you think of any way in which these spines help to scatter the seeds?

CHAPTER XIII

ABOUT RICE

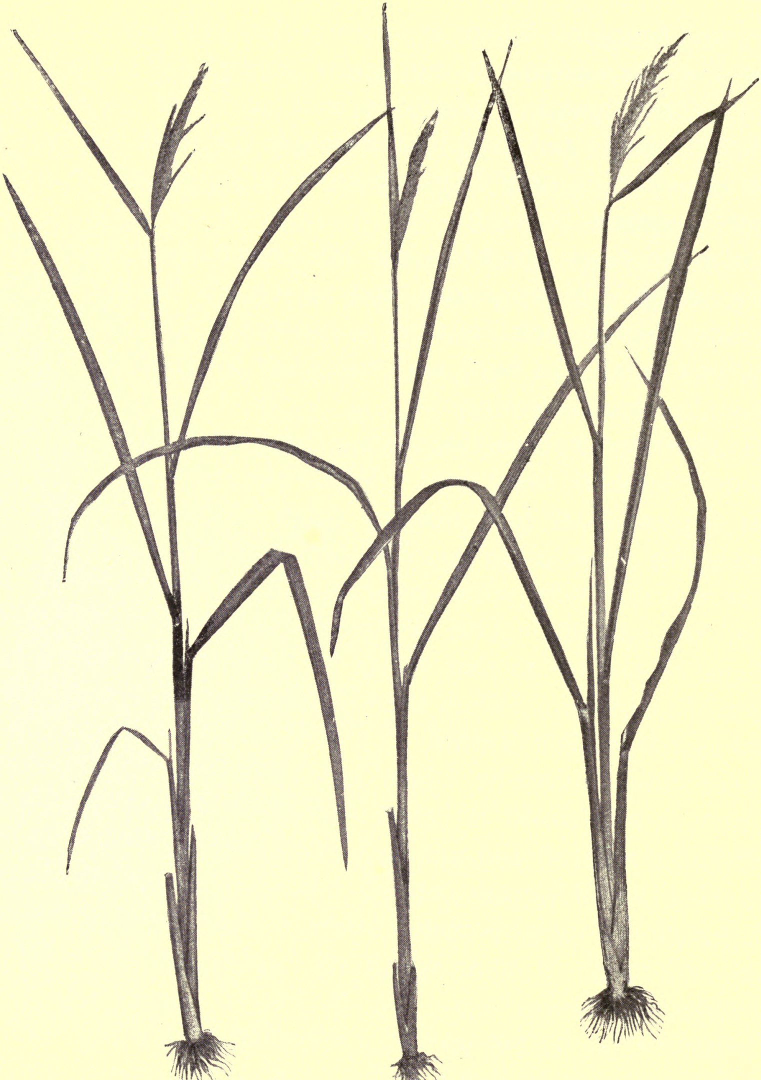
Wheat is the most important food-plant in the United States. Millions of dollars' worth of wheat is grown in the United States each year and much of it is sold to people of other countries. Yet wheat is not so important to the people of the United States as rice to the Filipino people. There are many other common plants which are used for food in the United States, so that if the wheat-crop should fail there would be many other things to eat. But when the rice-crop fails in the Philippine Islands there is much suffering and hunger. There are many other plants which are good for food, but the farmers do not grow enough of them to supply food for all the people. Much corn or maize is grown in some parts of the Islands and used by the people for food instead of rice, but the corn-crop is only large enough to supply the people who live where it grows.

Not many years ago when the rice-crop failed many Filipinos starved to death. Many people had to live on the seeds of a kind of common grass which you call amor-seco. The seeds of amor-seco are very small and hard and not good for food, but they kept many people from starvation.

It is pleasant to think that such a thing could not happen in the Philippine Islands in these days. When the rice-crop fails the Government is ready to buy rice in other countries and sell it to the people for what it costs. The Government did this in 1902, when there was a very small rice-crop on account of the death of nearly all the carabao. The Government also keeps large quantities of rice stored up so that it can be quickly distributed if there is danger of a famine. When there is not enough for people to eat, it is said that there is a famine.

There should never be a famine in the Philippine Islands, for no country in the world is better for the growing of food-plants. The Filipino people should not only grow enough rice for their own use, but they should grow enough besides to sell great quantities to the people of neighboring countries, just as the farmers of America sell much of their wheat to Europe and receive a great deal of money for it.

There is a far better way of preventing a rice-famine than by buying rice and storing it up, or by sending to other countries for it. This way is to learn carefully about the best methods of rice-



Three common kinds of Philippine rice.

cultivation and then to use them upon the rice-farms of the Philippines. When the Filipino farmers grow their rice in the best way, and have American machinery to help them in the cultivation, there will be very little danger of a famine unless all the carabao die.

There are many kinds of rice in the Philippine Islands. In the picture you may see three kinds which are common. Some of the kinds are much better for food than others, and it is important to be sure that the seed which is sown is the seed of the best kinds.

Rice belongs to the same family of plants as the common grass, and yet, as every Filipino boy knows, the grass is one of the worst enemies of rice. Whenever the water gets low on the rice paddies the grass begins to grow and crowd out the rice. If there is plenty of water on the paddy the grass can not grow as well as the rice, for the rice is a water-lover, but much water kills the grass. Another enemy of rice is the common field-mouse which eats it at the bottom whenever the field is too dry. So it is easy to see that the most important thing in growing rice is to have plenty of water.

Since it is important to have plenty of water standing on the rice while it grows, the best rice-land is very flat. The more the land slopes, the quicker the water runs off, and it is necessary to have the pilapil very close together to hold the water. What you call pilapil in the Philippine Islands are called dikes or levees in America. In Louisiana and Texas much rice is grown on very flat land, so the dikes can be built far apart. When the dikes are far apart it is much easier to use machinery in cultivating and harvesting the crop. This is another reason why flat land is much better than sloping land for the growing of rice.

The flowers of the rice-plant are very small and grow close together. They form an inflorescence, as in macahia. But the flowers of rice are quite different from those of macahia. They do not have any bright-colored petals. They do not attract the insects. But if you look carefully at the inflorescence of rice when the flowers are ripe you can find the stamens and the stigmas. The stamens produce a great deal of pollen. The stigmas are very large for such a small flower. From these things we may know that the pollen of rice is transferred by the wind, like the pollen of pandan. The rice is a wind-lover.

Taking the rice home.

The leaves of rice are very different from the leaves of any other plant you have studied. They are long and narrow, like leaves of grass. If you hold a leaf of rice or a leaf of grass up to the light you may see many fine lines in the leaf which are not so green as the rest of the leaf. These are the veins. In the leaves of banana, rice, grass, pandan, and many other common plants the veins of the leaves are all in the same direction or nearly so. They are called parallel-veined leaves. Many plants have leaves whose veins run in many directions, like the strings in the nets of the fishermen. Such leaves are said to be netted-veined. Do you find more leaves which are parallel-veined or more which are netted-veined?

The leaves of rice and grass point nearly straight to the sky. They do not seem to be getting all the sunlight they might get if their leaves had the position of the leaves of papaya. The sun shines directly upon the leaves of papaya. It shines obliquely upon the leaves of rice. So you see that rice, like pandan, seems to be afraid of getting too much heat and light.

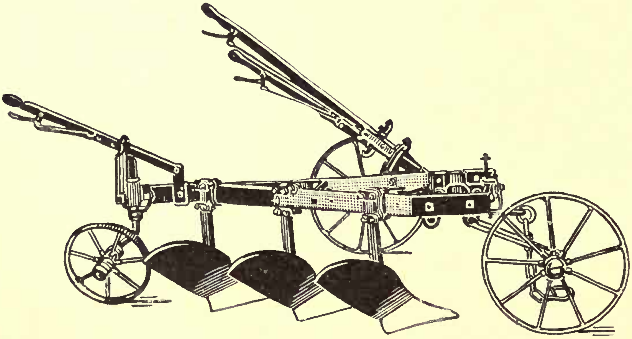
CHAPTER XIV

RICE-CULTIVATION

THE cultivation of rice in the Philippines is very different from what it is in America. Texas and Louisiana are the two great rice-producing States of the United States. In these States a man who works in the rice-fields is paid about two hundred dollars in American money each year, besides his board. The Filipino workman does not get nearly so much money each year. Neither does he produce nearly so much rice as the American workman. This is chiefly because the American workman uses machinery which the

Filipino does not have. One American workman with the aid of his machinery can take care of about eighty acres of land each year, and get from it about one hundred and sixty thousand pounds of unthreshed rice. The Filipino workman can take care of only about three acres of land from which he gets about fifteen hundred pounds of unthreshed rice. So you see that the owner of the land can well afford to pay his workmen nearly ten times as much as the Filipino workmen get, for, with the help of machinery, they produce nearly a hundred times as much rice.

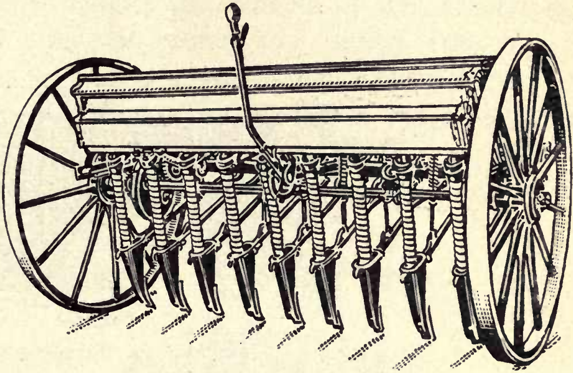
In the Islands we have lowland and upland rice. What native names do you give to these two kinds of rice? Probably every Filipino boy or girl knows that the best time to begin to cultivate lowland rice, which is the common kind, is in June or July. Before the rice is planted, the land must be very well plowed and harrowed. In America the plowing is done by gang-plows. These are plows which make three or four furrows at a time, and so do the work more rapidly than single plows. Mules pull these plows instead of carabao, and they go much faster. Six or eight mules are fastened to one gang-plow. In the Philippine Islands it is common to put the seed-rice into a part of the land called the punlaan late in the month of July. In August the young plants are carefully pulled up, their tops cut off,



Gang-plow.

and they are placed in the fields where they are to grow and bear seed. This is called transplanting.

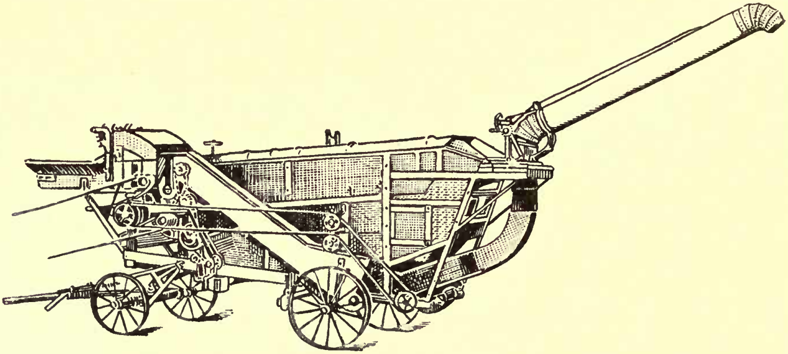
Now in America the rice is not transplanted. It is sowed from a machine called the seed-drill. The seed-drill plants the rice-seeds in just the right amount and just the right distance from each other, and does the work much more quickly than it could be done by hand.



Drill for planting seed.

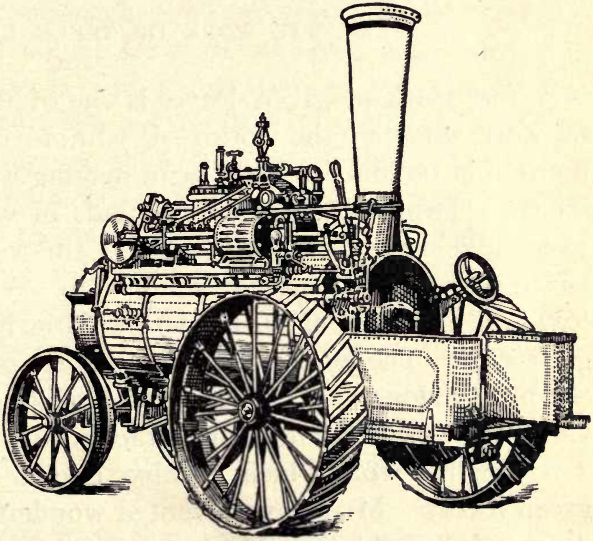
The largest and finest machines which are used in America in the cultivation of rice are the machines for harvesting and threshing. With the use of a machine which reaps and binds the rice at the same time, one man with the help of six mules can harvest from eight to twelve acres of rice in a day. It is very easy for you to see, however, that such a machine would not be a good thing to use upon rice-land where the pilapil or dikes are close together. The use of such a machine is practicable only in very flat land where the pilapil are far apart. Since the pilapil are only about sixty feet apart in most of the rice-fields of the Philippines it would not be worth while to use such a harvesting-machine.

The threshing-machine can be used no matter how close together the pilapil are, for the unthreshed rice is all brought to the machine. A large machine can thresh fifty thousand pounds of rice in a day, so you see that one machine could do all the work for many farmers. In America the owner of a threshing-machine takes it around from one farm to another and the farmer pays him for threshing his rice. Sometimes threshing-machines earn sixty or seventy dollars in American money in one day. Such a machine, and the engine which runs it, costs about twelve hundred dollars when it is new. They would be very useful in the Philippine Islands.



Machine for threshing rice.

The engine which you see in the picture is not used only to run the threshing-machine. It is also used to pull the threshing-machine over the country roads from farm to farm, for the machine is very large and heavy. In the picture of the threshing-machine you see on the right a long funnel. From the end of this funnel the rice-straw escapes and is piled up in a stack. This straw can be used to make the fire which runs the engine. The place for "feeding" unthreshed rice into the machine is at the upper left-hand corner of the picture. The threshed rice comes out at the bottom, near one of the larger wheels. There is a very important part which is not all shown in the picture. You may see one end of it on the left side of the picture. This part is the broad leather strap or belt which connects with the engine. The engine is placed about one hundred feet away from the threshing-machine so that there will be no danger that the sparks from it will set fire to the rice. The other end of the belt passes around a wheel on the engine, so that, when the engine turns this wheel, the wheels of the threshing-machine are also turned. In the same way, when you ride a bicycle, the energy of your legs turns a small wheel, and the turning of that small wheel causes the hind wheel of the bicycle to turn at the same time, for these wheels are connected by a chain. The chain carries the energy of your legs to the hind wheel.



Portable steam-engine.

You have learned that it is the threshing-machine which does the work of threshing the rice. You have learned that it is the steam-engine which gives the energy for doing this work. The energy of a steam-engine comes from the heat of a fire which changes water into steam. You have learned that it is the belt which carries the energy of the steam-engine to the threshing-machine. You know that the unthreshed rice is the material upon which this work is to be done. You know that threshed rice is the finished product of this work.

Now if you understand this outline of the work of a threshing-machine, it will help you very much in understanding the next chapter, which is about the work of green leaves. The work of green leaves may be very well compared with the work of a threshing-machine.

CHAPTER XV

THE WORK OF GREEN LEAVES

The work of green leaves is one of the most important kinds of work done in the world. It is more important than the work men do in building houses, or in making roads, or even in working on their farms. All these are kinds of work which make our life easier and more comfortable, but if the work of green leaves were to stop our lives themselves would stop. Without the work of green leaves all the work of the farmer would be in vain. He would never get a crop. The work of green leaves is not the making of food for the plants alone. It is the work of making food for all the world. Could any work be more important than this?

This is a work which nothing else in the world can do except green leaves. Men have invented wonderful machinery which can do wonderful things. Men can build engines which travel more than one hundred miles an hour. Men can send messages around the world in a few minutes. They can send messages through the air for hundreds of miles without even a wire between the place from which the message is sent and the place where it is received. But nothing in all the wonderful inventions of men is able to do the work of a green leaf. The machinery which is at work in a green leaf when the sun is shining on it is more delicate and more wonderful than any of the inventions of men. It is the only machinery in the world which is able to receive things from the soil and things from the air and out of these things make food which is good food for plants and animals alike.

Can you understand how it is that all our food and all the food of animals comes from the work of green leaves? We eat the seeds of rice, but it is in the leaves of rice that the food which is stored up in the rice-seed was made. In the same way all the nourishment which is in fruits comes from the work of the leaves. If you cut off all the leaves of the mango-tree, do you think the mango-tree will bear fruit? We eat the flesh of cattle and of hogs, but do not cattle and hogs get their food from plants? We use fish for food, and perhaps you can not so easily understand how the food of fish comes from the work of plants, but it is true. The large fish eat small fish, and the small fish eat smaller fish, and the smallest fish of all get their food from the millions and millions of very small plants which live in the water. Many of these plants are too small for the eye to see. So, wherever you get your food, you may be sure that it has come in the first place from the work of plants; work like that which goes on in the green leaves all around us.

It is very fortunate for men that the leaves make more than enough food for the plants alone. If the plants died when we take food from them, there would very soon be none left, but the green leaves produce enough food to keep the plants alive, and all the world of animals besides. We may say, then, that men and animals live on the surplus of food produced by green leaves.

You have already learned that the materials out of which the green leaves make food for the plant come from the soil and the air. In studying about papaya you learned that the little root is the first part of the young papaya to begin work, and that its work is to find in the soil the things out of which the leaves can make food, and have them all ready for the leaf when it has unfolded in the sunlight. The material which the roots get from the soil is like the unthreshed rice which is fed to the threshing-machine. The material from the soil passes along the stems and is fed to the machinery of the leaves.

We must next understand where the energy comes from to run the delicate machinery of the leaf and make food out of the materials of the soil and the air. Have you ever noticed that green leaves can not live without sunlight? If you put a board upon the grass and lift it up after a few days you may see that all the grass has turned yellow. It has lost its green color and has begun to die. We may be sure from this that the green color of leaves has something very important to do with the light. When a plant is growing inside of a house its leaves turn toward the window. They seem to be trying to reach the light. Now if you should take a piece of black paper and fasten it very gently to the surface of a large, green leaf, so that it would not injure the leaf, you could prove that without the light no food is made in the leaf. Light can not pass through the black paper. If the plant is in the sunlight all day long there will be a good deal of food made in the leaves, but you will find that under the part which was covered by the black paper no food has been made at all. When you study botany you will learn how we may examine leaves to see what parts contain food and what parts do not, but even now you can understand how we may prove that without light no food is made in the leaves. Also, you understand that the first thing which happens to green leaves when they are in the dark is that the green color all disappears. So you know that the green color of plants can not do its work without sunlight. When the light does not shine upon it, it soon disappears. This green substance in plants is called chlorophyll, a word which means leaf-green. The chlorophyll has a very important part to do in the work of making plant-food.

You have learned that food is made only while the light is shining on the leaves. It is the light of the sun which gives the energy for doing this work. The sunlight is like the steam-engine which gives the energy for running the threshing-machine. It is the chlorophyll or green substance in leaves which catches the light of the sun and carries the energy of sunlight to the delicate machinery of the leaf. It is like the belt which carries the energy of the steam-engine to the threshing-machine. The chlorophyll does not do the work itself, but without the chlorophyll and without the sunlight the delicate living machinery of the leaf would be quite unable to do the work of making food. Just so the threshing-machine would be quite unable to do the work of threshing rice without the belt and the steam-engine. Just so a bicycle can not run without the energy of your legs and a chain to carry that energy to the hind-wheel.

CHAPTER XVI

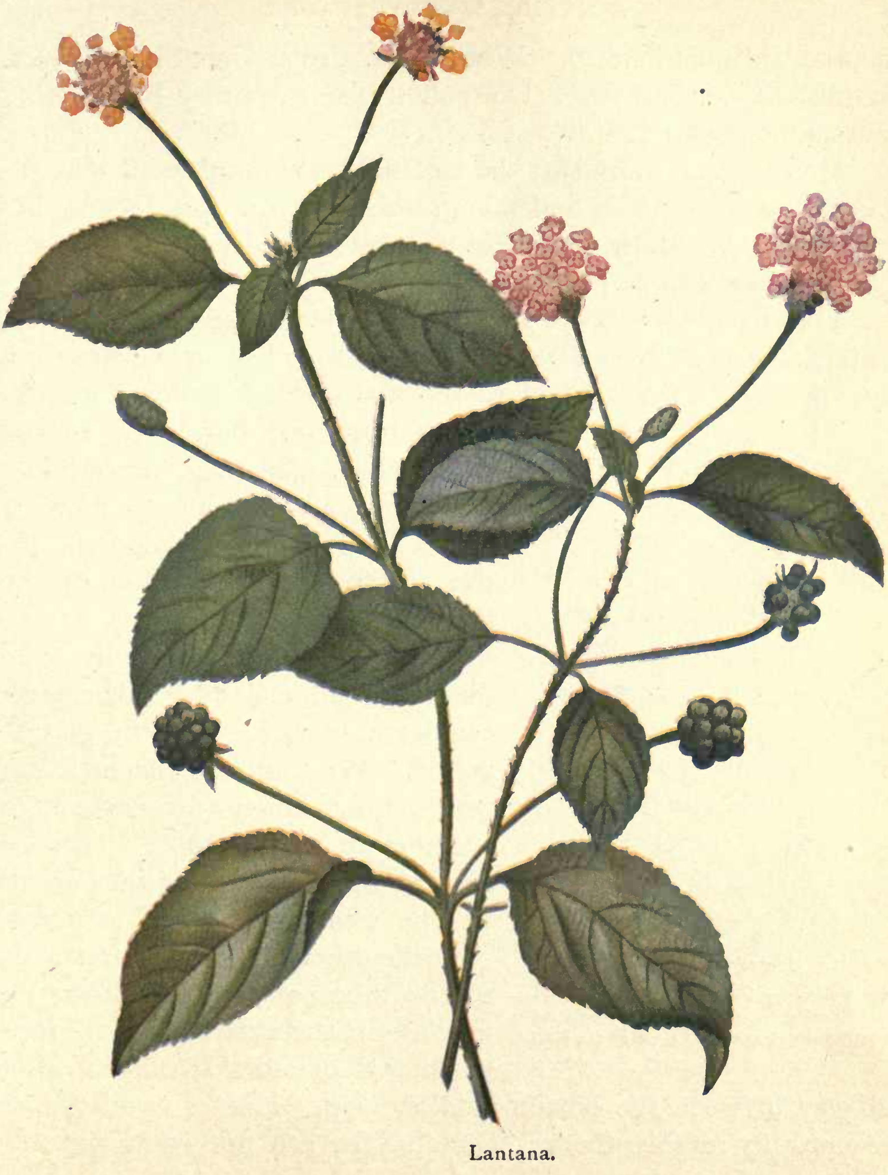
THE LANTANA

THE lantana is a shrub which is common in the Philippine Islands and in many other parts of the world. It is a very successful plant, spreading rapidly wherever it begins to grow unless it is carefully cut out. It is not a plant which has any plant-products which are valuable to man, and in some parts of the world it is one of the worst enemies of the farmer. In the Hawaiian Islands the farmers would give many thousands of dollars if there were no lantana growing on their farms, for it crowds out and kills many valuable plants. In the Philippine Islands the lantana is not so common as it is in the Hawaiian Islands, yet there is danger that it may become so common that it will cause much loss to the farmers. The lantana is a plant which it is very well to kill. Its seeds are scattered everywhere by the birds, so that it spreads rapidly from place to place.

Although the lantana is a very troublesome plant for the farmer, it is a very convenient plant to use in learning about the structure of flowers and the way in which seeds are scattered. In the picture you can see the little, round fruits of lantana which grow in a close cluster, and when they are quite ripe they become black and juicy. Many kinds of birds are very fond of eating the little fruits or berries of lantana. In the center of each little fruit is one hard seed, and when the bird eats the fruit it also swallows the seed. It does not injure the seed of lantana to be eaten by birds. The birds fly away and after a while the seed is passed from their bodies, and if it falls in a good place it soon begins to grow into a young lantana-plant.

You may always tell a lantana-plant by its pink and orange-colored flowers which grow close together in a group or inflorescence. The leaves are stiff and hairy. If you look on their under side you can see the veins very plainly. They are very delicate and beautiful. Is it a netted-veined leaf like the leaf of papaya or a parallel-veined leaf like the leaf of rice or of banana?

The leaves are arranged upon the stem in a very regular way. They are in pairs, each leaf with another leaf just across from it on

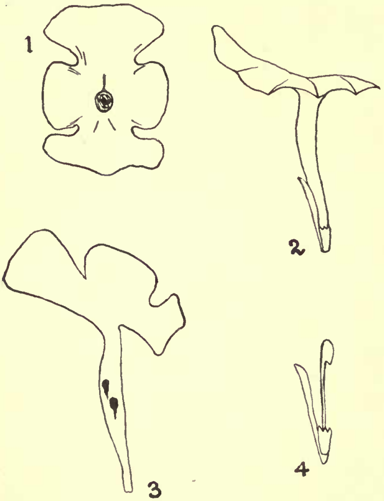


Lantana.

the other side of the stem. When leaves are arranged like this they are said to be opposite. Do you know any other plants whose leaves are opposite?

Many people think that the lantana has an unpleasant odor, but it is not a strong odor and should not keep you from looking at it very carefully. Many people call it the cemetery-plant, because it is nearly always to be found in cemeteries.

You have already learned that the lantana uses the birds to scatter its seeds. If you watch a lantana for a little while on a sunny day you are almost certain to see many small, yellow butterflies flying from one flower to another. The lantana uses these butterflies to carry its pollen from one flower to another. Just as we called the pandan a wind-lover, we may call the lantana a butterfly-lover.



Lantana flower.

1. Front view, showing irregular shape of corolla. 2. Side view. 3. Corolla tube cut open, showing position of stamens. 4. Calyx and pistil.

Now let us look carefully at the flowers of lantana and see whether we can learn how the butterfly gets the pollen. We find that the little pink petals of each lantana-flower are united together to form a tube. There are four of these petals and they are not all the same size. Two are larger than the other two. If we open one of the tubes of the little flower we may see that the stamens are fastened to the inside and that they are about half-way between the bottom and the top. How do you suppose the butterfly reaches them? Certainly he can not enter the tube, for at the top it is hardly large enough to let an ant enter. To answer this question we must first catch a butterfly. You can do this easily with your hat. Then, if you hold the butterfly very carefully and look on the under side of its head, you will find in the place where the mouth ought to be something which is rolled up tightly. This is the very peculiar tongue of the butterfly. When it is unrolled it is almost as long as the butterfly's body. With the point of a pin you can carefully unroll the tongue of the butterfly and you will find that it is almost exactly as long as the corolla-tube of the lantana-flower. Now you see how the butterfly reaches the pollen.

But is it for the pollen alone that the butterfly visits the lantana? Why should the butterflies spend their time in carrying pollen from one flower to another if they get nothing for it? If they eat the pollen then they are the enemies of the flowers and not their helpers. If the butterflies go to the lantana-flowers only to get pollen, then why should their tongues be long enough to reach to the bottom of the tube when the pollen is only half-way down?

There is one answer for both these questions. The butterflies do not carry pollen from one lantana-flower to another for nothing. They are the servants of the lantana and do this work for them, but they get well paid for it. The flowers pay them by giving them plenty of nectar. The nectar is at the bottom of the corolla-tubes, so that the tongue of the butterfly must be as long as the tube or it could not reach it. While the tongue is reaching for the nectar it must always rub against the stamens and the top of the little pistil which is just beneath the stamens. So, while the butterfly is getting its food, it is certain to carry the pollen of one flower to the pistil of another and this is just what the flowers want.

If you pull off the corolla-tube of lantana and hold it upside down, when you squeeze it you will see a little drop come out of the lower end of the tube, unless the butterfly has already visited the flower and taken this sweet drop away. This drop is the nectar.

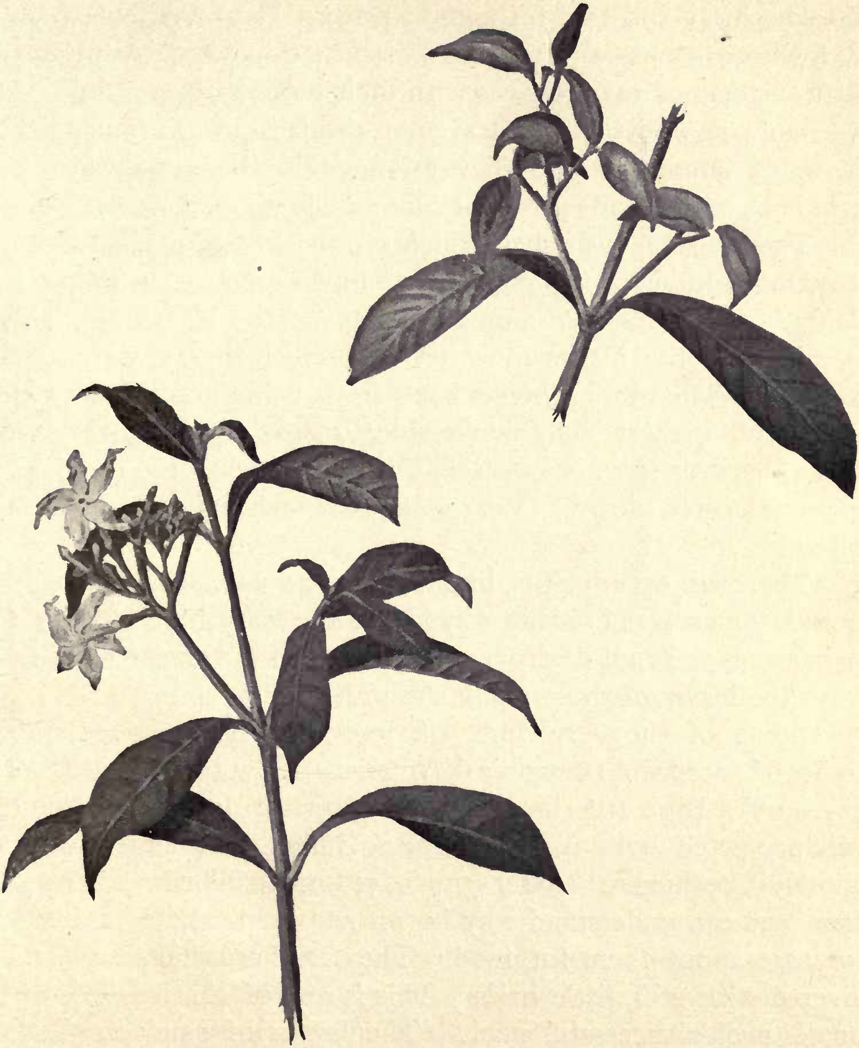
CHAPTER XVII

PANDACAQUI

THE pandacaqui is another shrub. It is sometimes just about the size of lantana, but usually it is larger. Its stems are more woody than the stems of lantana.

Pandacaqui is common in nearly all parts of the Islands. After you have once learned to know it, you can always tell it by the bright white flowers. The petals are united into a tube just like the petals of lantana, but there are five of them instead of four, and they are much larger. The flowers do not grow quite so close together as the flowers of lantana, and the petals are all the same size. Only two or three of the flowers in an inflorescence of pandacaqui are in bloom at the same time.

This plant has one thing which is quite different from any plant you have yet studied. If you break the young stem a white juice, like milk, comes from the broken end. This white juice is very sticky and after a little while it becomes hard. There are some trees which grow in the Philippine forests which have a milky juice like pandacaqui. Rubber and gutta-percha are made from a milky juice which looks much like the juice of pandacaqui when it first runs out of the trees. The natives cut the stems of these trees with



Pandacaqui.

their bolos, and after the juice has run out and become hard it may be taken away and sold for a good price. Have you ever seen any trees whose stems are cut with bolos in this way? Why do men cut the stems of mango-trees with their bolos?

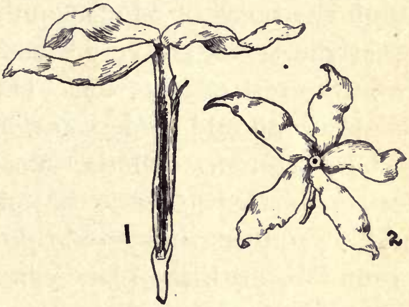
Do you find that the leaves of pandacaqui are much like the leaves of lantana? Are they arranged in the same way on the stem? Are the veins parallel or like a net?

There are many animals which use the leaves of plants for food. How many kinds of animals have you ever seen eating the leaves of plants? Of course the animals which eat the leaves of plants are enemies and the plants must try to protect themselves as well as they can. The grass protects itself from being all destroyed by the horses and the cattle by being able to grow up again very rapidly after the leaves have been eaten. It does not kill the grass to have its leaves eaten down. Very soon new ones are put up from the roots.

There are other plants, like lantana and pandacaqui, which must protect themselves in other ways from the leaf-eating animals, for if their leaves were all destroyed they would soon die. How do you think the leaves of these plants are protected?

Some of the very worst of leaf-eating animals are different kinds of insects. In tropical America the ants often eat all the leaves off a large tree in one day. Now the leaves of lantana are well protected both from leaf-eating insects and larger leaf-eating animals like horses. After you have once rubbed your hands on them you can understand why horses and cattle and even insects do not care about them for food. They are hard and tough, and are covered with stiff, little hairs. This is one of the reasons why lantana is such a successful plant. The leaves of pandacaqui are not so well protected as the leaves of lantana, and perhaps this is a reason why it does not spread so rapidly. The leaves of pandacaqui are smooth and rather soft, but they are protected by the milky juice which is in them. The milky juice gives them a very bad taste. Many other kinds of plants are protected from the leaf-eating animals by having in them juices which either taste very badly or else are poisonous. Animals are able to tell which plants are poisonous and which are not much better than men can.

The pandacaqui has a very peculiar flower and a very peculiar fruit. The petals of the flower always look as though they had been twisted. They are all the same size, but they are not straight like the petals of other flowers. If you cut through the bud or very young flower of pandacaqui you may see how the petals are closely twisted together before the flower opens.



Pandacaqui flower.
1. Flower cut open. 2. Front view.

The opening of the corolla-tube of pandacaqui is even smaller than that of lantana, and around the edge of it you may see a hard little rim, like the curb around the top of a well. The stamens of pandacaqui have sharp points, and you will find them about one-third of the way down the tube. Have you ever seen butterflies visiting the flowers of pandacaqui? When you cut open the twisted tube of the flower you will find that the stigma is very close to the pollen-sacs or anthers. From this we may think that pandacaqui does not have cross-pollination like lantana, but that the pollen falls on the stigma of the same flower.

The fruit of pandacaqui is even more peculiar than the flower. If you pull to pieces one of the flowers you will find at the bottom the little green ovary which is to become the fruit. It seems to have just one part, but, after the work of the flower is done and it has fallen off, this ovary begins to separate into two distinct parts which bend away from each other. You can see this plainly in the pictures. Each of these parts has the shape of a crescent, like the moon when it is young. They bend farther and farther apart as they grow larger, so that when the fruit is ripe there seem to be two very distinct fruits, which have come from one ovary.

When the fruit of pandacaqui is ripe it changes its color from green to red. Can you think why it does this? How do you think the seeds of pandacaqui are scattered? When the fruit bursts open the seeds are very easily seen, for they have a different color from the rest of the fruit. Do you know what this color is?

You should understand very well why it is necessary for seeds to be scattered. All the successful plants have very good ways of scattering their seeds. No matter how many good seeds a plant might produce, they would do very little good if they all fell to the ground beneath the plant which produced them. There would not be room for more than a very few of them to grow up into good plants.

CHAPTER XVIII

ILANG–ILANG

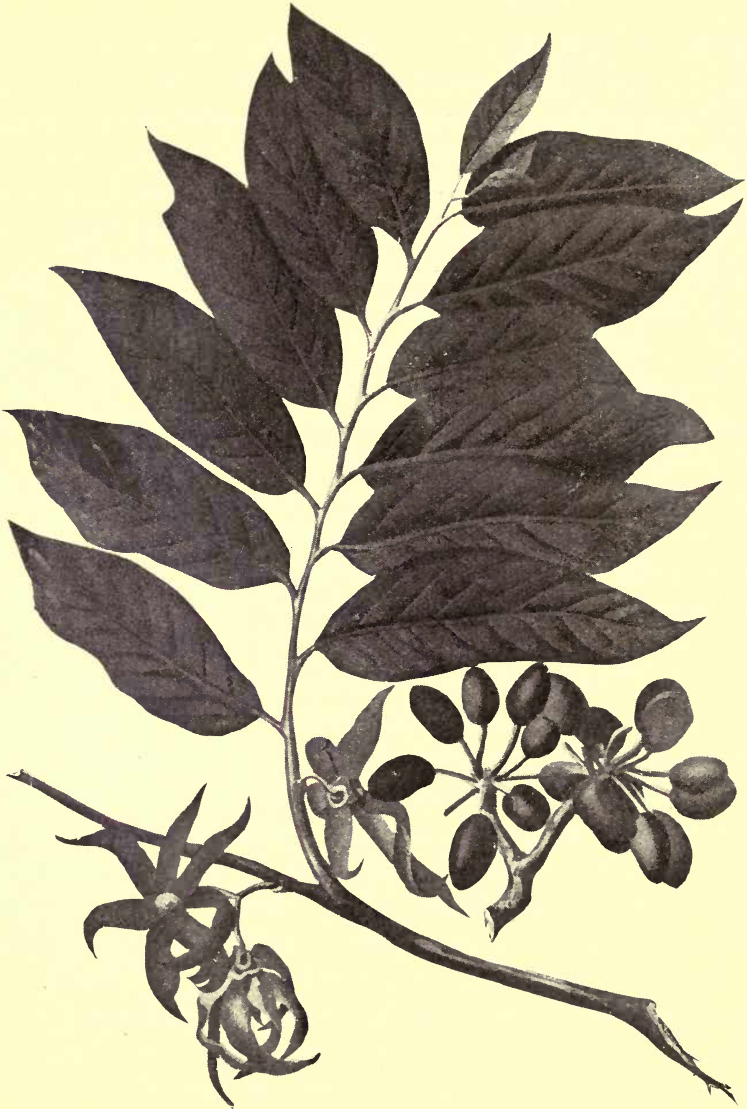
Of all the flowers in the Islands the ilang-ilang has the sweetest odor. There is no flower which gives greater pleasure to the Filipino people than ilang-ilang. It gives profit as well as pleasure, for from the extract or essence of the flowers valuable perfumes are made. This essence of the ilang-ilang is one of the most valuable plant-products in the world. From about seventy-five pounds of flowers one pound of the best ilang-ilang essence is obtained, and this first quality of essence is worth about forty dollars, gold.

The ilang-ilang is a good-sized tree with rather large, smooth leaves. It is often grown as a shade-tree for cacao-plants. A farm which has good cacao-trees and good ilang-ilang-trees growing together should be very profitable.

You will find that the flowers of ilang-ilang have a structure which is very different from any flowers you have yet studied. Yet, like all other flowers in the world, the purpose of the ilang-ilang-flower is to produce good fruit and seeds. It is like a different invention to do the same kind of work.

The outermost part of the flower is called the calyx. You can see it best when you turn the flower upside down. Then you can see three, short, thick leaves which are triangular in shape. These leaves form the calyx. The calyx is for the purpose of protecting the very young flower, or bud.

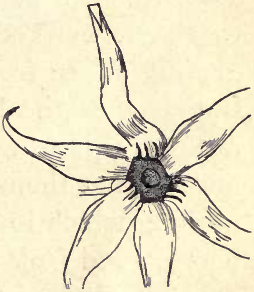
Perhaps the most interesting as well as the most valuable part of the flower is the corolla. It is from the corolla that the valuable essence of ilang-ilang is made. The corolla consists of six long and narrow petals which have a greenish-yellow color. It is quite peculiar that the bud opens while these petals are quite short. They gradually increase in length until they have about the shape of a wide strap. You may see quite plainly that the petals are arranged in two different sets or whorls, three in each, one whorl outside the other. A whorl is a set of parts of a plant, either leaves or flower-parts, which is arranged in a ring around the stem. Many plants have their leaves arranged in whorls. In the common kind of ilang-ilang the three petals of the inner whorl are marked by red



Ilang-ilang.

stripes at the bottom. Can you find these stripes? They seem to be for the purpose of guiding the visiting insect to the place where the nectar may be found, and where he will be sure to get some of the pollen on his body. They are called nectar-guides.

Do you think that if you had plenty of ilang-ilang-flowers you would know how to get the valuable essence out of the petals? Perhaps you have seen how this is done, although you may not understand it. You know that when water is very hot it begins to boil, and presently it passes into the air as steam. You know that if you hold something cold, like the blade of a knife, in the little cloud of steam presently you will see drops of water forming on it. The cool surface of the knife changes the steam, which is a kind of gas, back into a liquid again. This process of changing a liquid into a gas and then changing it back to a liquid again is called distillation. The water which collects on your knife-blade when you hold it in a cloud of steam is distilled water.



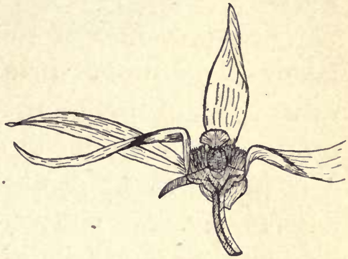
Flower of ilang ilang, showing nectar-guides.

The valuable essence of ilang-ilang is obtained by this same process of distillation. The essence is in the petals in liquid form, but if you tried to get it out by crushing the flowers you would get it mixed with other liquids which spoil its value. But when you heat the flowers the most fragrant essence is the first to be changed into a gas. Different kinds of liquids are changed to gas by different amounts of heat. Since the best essence of ilang-ilang is changed to gas by less heat than the other kinds of liquids in the flower this is a way by which we may separate it from them. So when a man is trying to get the best essence of ilang-ilang he must be careful to collect the first gas which comes from heating the flowers, and keep it separate from the rest. When this gas touches a cold surface it changes to drops of liquid, and these first drops are the best distilled essence of ilang-ilang.

Now the parts of the ilang-ilang-flowers which are most different from the flower-parts you have already studied are not the most valuable parts to man, but they are the most important parts to the flower. They are the parts which are necessary for the making of the fruit and seeds, and you already know that the sweet fragrance of the flower is only to help them do their work. These necessary parts are in the very center of the flower. When you first look at them you see nothing which looks like stamens, and nothing which looks like a pistil. Yet you know that if the flower makes good fruit and seed these parts must be there.

The part of the flower inside of the corolla has the shape of a triangle. In the center of this triangle there is a round, green part, like a small button. Do you find that part? If you take a sharp knife and cut through the very center of a mature flower, right through the little green button, you will have a view of the flower which will help you to understand its parts. In the picture of this view of the flower you may see that the parts to right and left of the center contain very small grains, which are just dots in the picture. You can see them better, perhaps, if you cut open a real flower. These dots are the grains of pollen. The stamens which contain them are very different from any stamens you have yet studied. The flower of ilang-ilang contains more than a hundred stamens.

In the very center of the flower you find other small round bodies, a little larger than the grains of pollen. These are the ovules or very young seeds. The ovules are not contained in a single part, as in all the other flowers you have studied, but there seem to be about fifteen very small parts, each one of which contains a number of ovules. These small parts unite at the top to form the green button you have already seen. Each of these parts is called a "carpel." In all the flowers which you have already studied the carpels have been united into one part, which we have called the pistil, but there are a few flowers, like ilang-ilang, in which the carpels are separate. Just as we say that the corolla is composed of petals, and the calyx composed of sepals, we may say that the pistil is composed of carpels, although these carpels are usually so closely united that they seem to form a single part, as in the lantana and pandacaqui which you have just studied.


Flower of ilang-ilang cut open, showing the many stamens and carpels.

CHAPTER XIX

CACAO

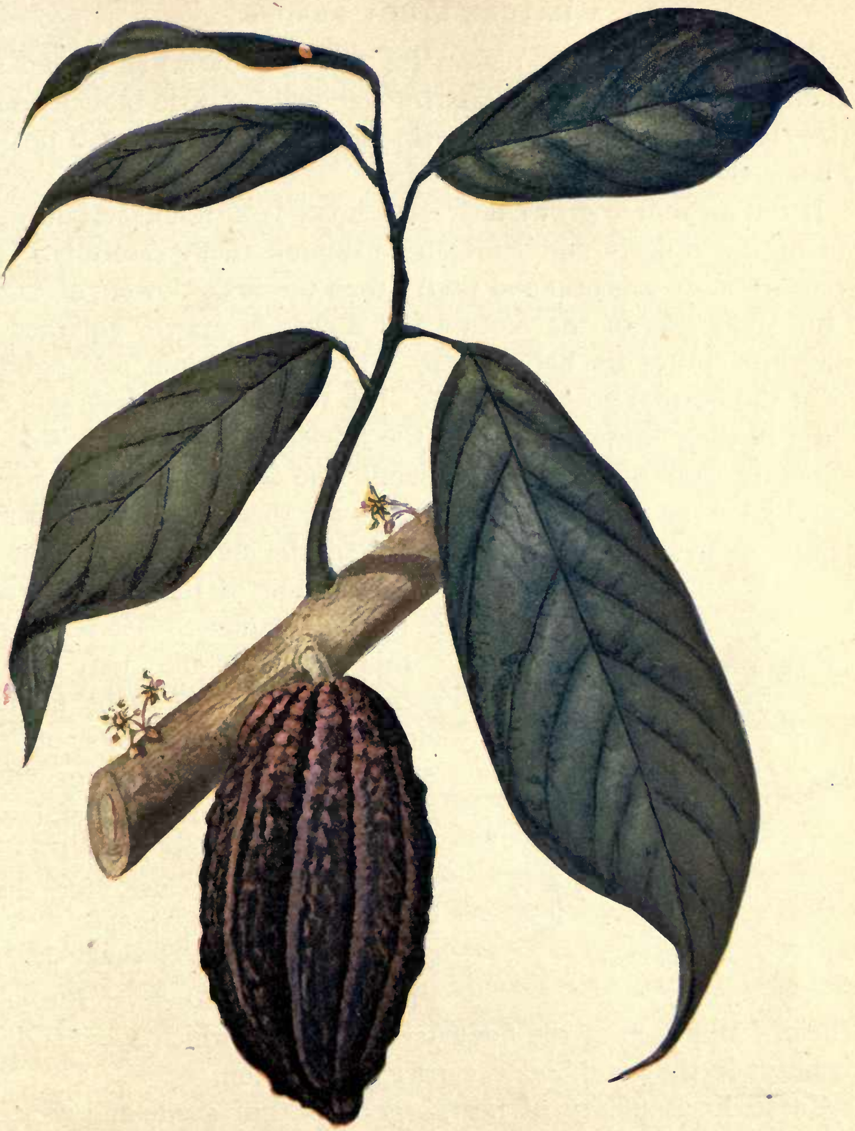
HAVE you ever known a boy or girl who does not like chocolate? If Filipino boys and girls do not like it they are very different from the young people of America. Chocolate candy and chocolate ice-cream are two of the things most precious to the appetites of American children. A boy or girl who does not like them would be as hard to find in America as a cacao-tree itself.

No doubt you know that chocolate comes from the cacao-tree and that this tree grows in the Philippine Islands. Perhaps you do not know that it never grows in the countries of temperate regions. This is one of the reasons why chocolate is so valuable. It is used all over the world, yet it can be produced in only a small part of the world.

Cacao is one of the most important economic plants of the Islands. Economic plants are those whose products have a money-value. The value of the product of one good cacao-plant is sometimes as much as four or five dollars in Philippine money in one year. This is one of the plants which should be cultivated much more than it is to-day. Its cultivation is not difficult, and some of the best places in the world for growing it are to be found in the Philippines.

The cacao is a small tree with rather large leaves. Its leaves and stems are much like the leaves and stems of other trees, but its flowers and fruit are very different. The tree carries them in a peculiar manner. The flowers of most trees are borne upon special stems which come from the ends of the branches, but the flowers of cacao are not to be found at the ends of the branches. You will find them upon the rough coat or bark of the branches, and even upon the main stem or trunk of the tree. It seems quite strange to find the delicate pink and white flowers of cacao fastened directly to the rough bark. This is an arrangement of the flowers which is never seen upon the trees of temperate regions, although it is not uncommon in the tropics. Do you know any other trees which bear their flowers and fruit on the bark?

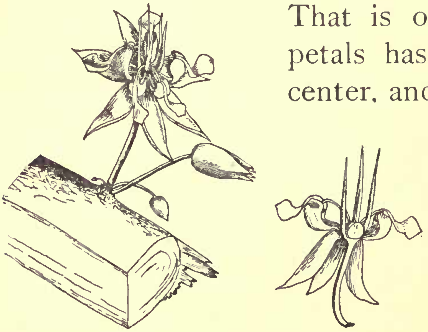
It would not be difficult for you to understand why flowers sometimes grow from the bark of tropical trees, but never from the bark of the trees of temperate regions, if you could see the bark of these two kinds of trees side by side. The bark of trees which grow in tropical countries is usually quite soft and smooth, while the bark of trees which grow where winter comes is nearly always thick and



Cacao.

heavy. Can you see the reason for this? Now when flowers are borne on the bark, it is necessary for the delicate little branch which carries them to first push its way through the bark. It can not do this when the bark is thick and tough.

If the cacao-tree grows near your home you should certainly get some of the flowers and fruit and examine them carefully. No flowers are more graceful and pretty than the little flowers of cacao. On the right side of the picture the flower is drawn, enlarged to about three times its natural size. The five straight and pointed parts at the bottom are the sepals. The form of the petals you can see best in the picture of half of the flower. On the left side of the picture you may see very plainly the shape of one of these gracefully curved parts. Now can you see that there is something which bends over from near the center of the flower and seems to be fastened to the middle of the curved petal? That is one of the stamens. Each of the petals has a rounded, hood-like part in the center, and each of them seems to be holding down the head of one of the stamens. The five stamens which stand up so straight, and are pointed, seem to be more for decoration than for use, for these stamens carry no pollen. You can plainly see that there are no pollen-sacs or anthers at the ends of them. But each of the five curved stamens, which seem to hide their heads in the petal-hoods, carries good pollen.


Flowers of cacao.

Cacao loves plenty of heat, a good deal of shade and water, a deep soil, and as little wind as possible. It should not be grown very near the sea. Some of the valleys of the Islands, sheltered from the winds of the coasts, and with a good deal of moisture the year round, are ideal places for cacao. It is better to grow it on flat land than on the slopes. The best places seem to be in Mindanao and the Visayas, yet there are many excellent places in the sheltered valleys of Luzon. Many good cacao-trees are in Pasay, near Manila.

The cacao may be planted close together, for it does not need much light, and it loves to "swelter in its own heat," like people in a crowd. You can always tell when the fruit is ripe by the pleasant odor of chocolate which comes from it then. There are two or three kinds of cacao in the Philippine Islands and the ripe fruit is either red or yellow.

The many seeds are arranged inside the fruit in very regular rows. It is from the seeds that chocolate is extracted. The fruit must be gathered by cutting it, not by twisting or pulling, for the cacao is a very tender tree. It is almost certain to be injured by the wounds made from pulling off the fruit, since, if the bark is torn, this gives a good place for the entrance of the insects which attack the wood.

After the fruit is picked, it needs to be piled in heaps in a closed room, or put in bags, and left for a few days. This is the process of "sweating." After the sweating, it is much easier to separate the seeds from the fruit. The seeds now have a rich brown color, and need to be carefully dried in the sun. After that is done, they are ready to be ground up and have the valuable extract taken from them. Most cacao-farmers sell the cacao-seeds without grinding them.

Monkeys, rats, and parrots, as well as insects, are enemies of the cacao and the cacao-farmers.

CHAPTER XX

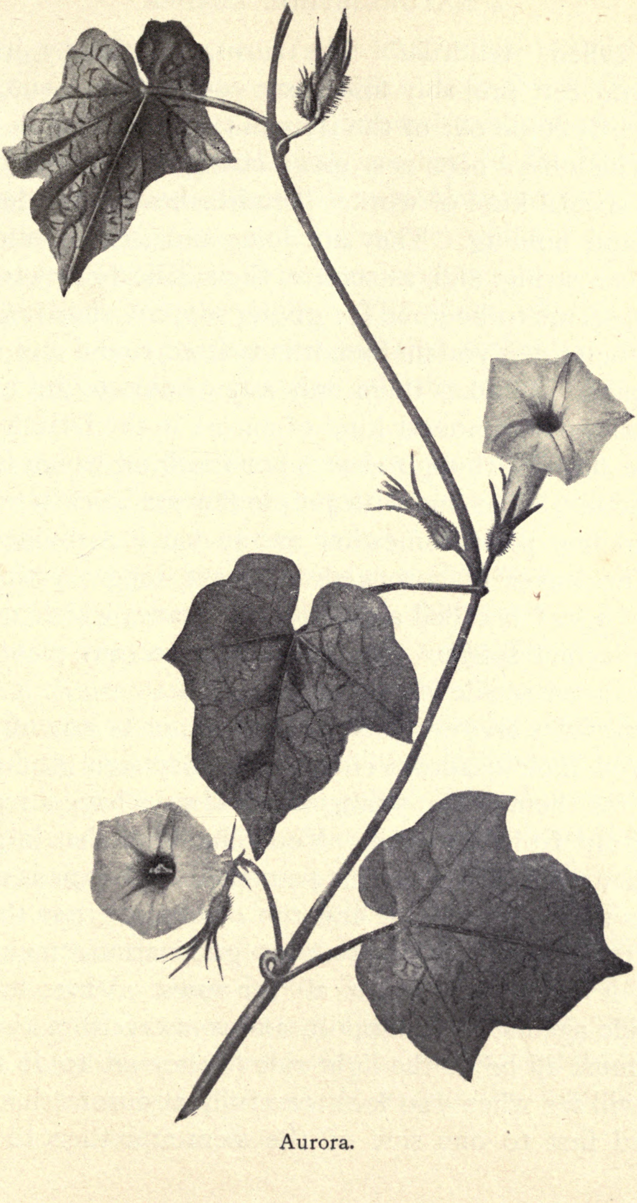
THE AURORA; A VINE

THE aurora or morning-glory is one of the commonest and most beautiful of Philippine flowers. It is well called the "glory of morning," for in the morning you may see its hundreds of delicate purple, or blue, or pink corollas, but in the afternoon they have wilted, and their glory is gone.

Aurora is the first plant you have studied which has the habit of climbing upon other plants or upon the sides of houses. Such plants are called vines. The stems of vines are not strong enough to stand alone. They must have some other support to help them get their leaves up into the life-giving sunlight.

The difference between erect plants and vines may be compared to the difference between wind-loving and insect-loving flowers; each has some advantage over the other. You can see that vines have an advantage over erect plants because they do not have to spend a great deal of their strength in making stiff and woody stems. They make other plants do for them the work of holding their leaves up in the light. Have you not seen mango-trees almost covered by an aurora-vine? On the other hand, if the aurora can not find anything to climb on, then it is not so well off as if it had a stiff, strong stem of its own, no matter how hard work it may have been to make that stem. In that way the erect plants certainly have an advantage over the vines. They are more independent.

Some vines climb by twisting their stems about the supporting branches of other plants, while others have special little holders

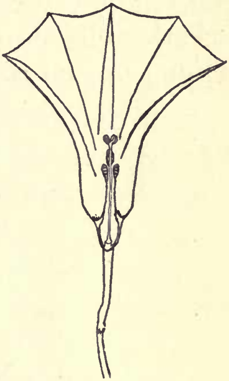


Aurora.

which are called "tendrils." The aurora climbs by its twisting stem, but you can probably find near your house a vine with tendrils. Tendrils come out of the stems like leaves, and in truth they are leaves which have been very much changed in shape so that they can do this special kind of work. Tendrils have a wonderful power of feeling and holding. They are long and slender, almost like a piece of green string, and, as soon as their delicate tips touch something which seems to be good for giving support, they begin to wind about it. Sometimes you find tendrils twisted round and round into a perfect spiral. It takes them only a few hours to get a firm hold.

Perhaps the commonest kind of aurora in the Islands is the one with purple flowers, though that is not the kind which is drawn in the large picture. The one with purple flowers has leaves which are divided into five parts, somewhat as the hand is divided into five fingers. The leaves of aurora always have long "petioles." The stem part of a leaf is called a petiole, and leaves which do not have petioles are called sessile. Do you remember any plant you have studied which has sessile leaves?

Long petioles are very useful to aurora, or to any other kind of vine. If you look at aurora closely you may soon understand the need it has for them. The young leaves always have a regular place for coming out from the stem. You remember that in pandacaqui and in lantana the leaves are in pairs, and each pair is arranged at right angles to the one above and the one below it so that they do not shade each other. This is a very good arrangement for erect plants, but it would not do at all for vines. Vines must always have one side against their support, and so away from the light, yet the leaves must all be on the light side if they are to do their work. Now you will see when you look carefully at aurora that the leaves are fastened first to one side of the stem and then to the other, although the broad, flat part of the leaf, which is called the blade, always seems to be on the sunny side. It is the work of the petioles to carry the leaves which are fastened to the shaded side around to the sunlit side. You can easily see that, if the leaves of aurora were sessile, those on the shaded side would have a very bad time of it. You may often find petioles of aurora which have twisted clear around the stem in trying to keep their leaves in the light. The stem of aurora keeps twisting as it grows and that makes the work of the long petioles all the more necessary.


Flower of aurora cut open.

You may often find on the aurora two small leaves just at the place where the petiole joins the stem. These small leaves are called "stipules." The stipules have just the same shape as the large leaves. Although they are so small, they seem to be for the purpose of catching and using any light which shines past the larger leaves.

The flowers of aurora are borne on slender branches which arise one from each leaf-axil. The axil of a leaf is the place where the leaf or its petiole joins the main stem. The flower-bearing branch is called the "pedicel." The pedicels are just about the same length as the petioles, for the flowers, as well as the blades of the leaves, must be in the sunlight. You will notice that there is one flower for each leaf, but that the leaves last much longer than the flowers. Do you know how many days a flower of aurora lasts? The blossom of to-day is always a certain distance from the end of the stem, while the faded flower of yesterday or the day before is to be found in the axil of the leaf just behind it, and the bud of to-morrow's flower is in the axil just ahead.

The picture of the flower cut open shows very plainly the arrangement of its parts. The pretty corolla has the shape of a bell and is composed of five united petals. You can tell this from the five pointed parts, like a star, which form the thicker part of the corolla. The stamens are not all the same length and grow very close to the pistil. The stigma has two parts. Do you know whether the aurora produces good fruit or whether it produces its young in some other way?

CHAPTER XXI

MANGO

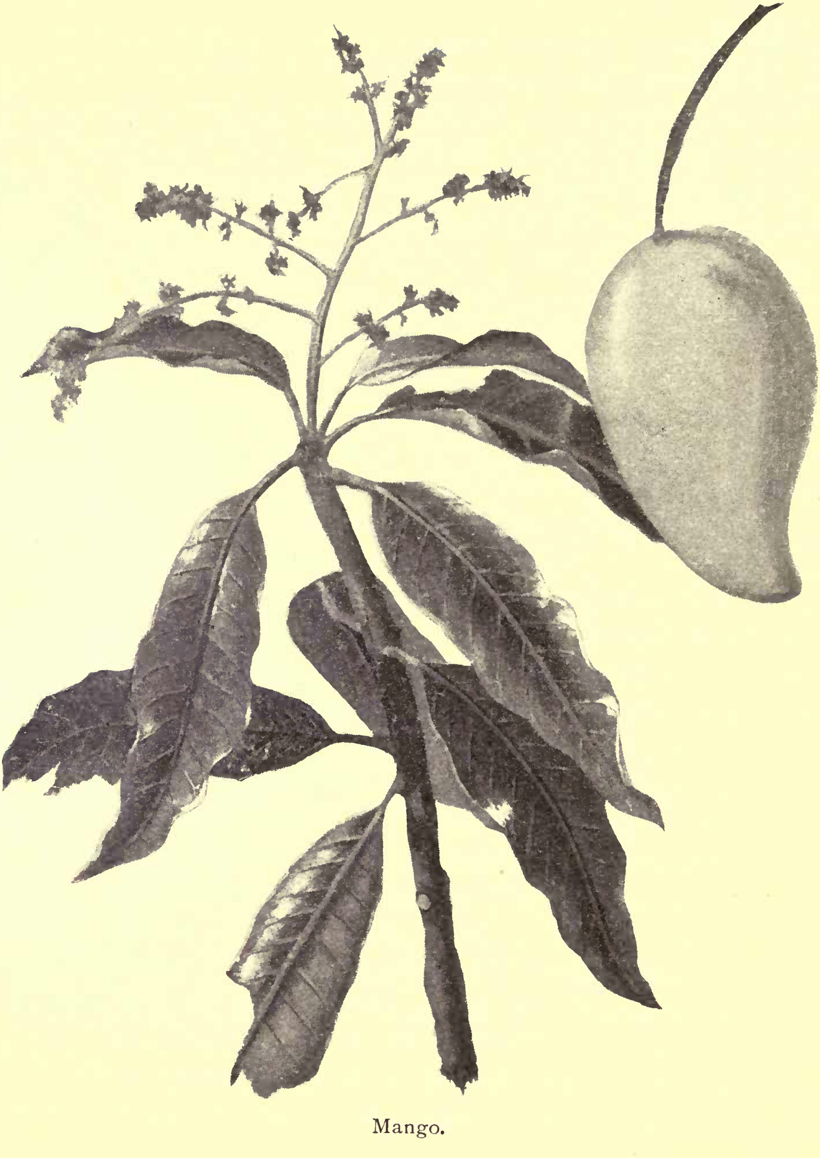
HERE is a Nature-Study subject which should be interesting to all people who live in the Philippines. This is one of the subjects about which you may be able to tell your teacher more than is printed in this book. All Filipino boys and girls know a good deal about mangoes and mango-trees, just as American boys and girls know a good deal about apples and apple-trees. Apple-trees and mango-trees are both easy to climb. They both give a pleasant shade from the hot sun and bear fruit which is very good to eat. No wonder they make very attractive playgrounds for boys and girls!

The mango has been called the "king of tropical fruits." It grows in nearly all tropical countries, but people who have eaten good Philippine mangoes say they are the best of all. This is a product of which we may be very proud. One of the first questions usually asked by the many visitors who come to Manila is about the famous mangoes, and they are greatly disappointed if it is not the right season for them.

The only unpleasant thing about a mango is the trouble of eating it. You know how hard it is not to get the rich, juicy pulp on your face and fingers and clothes. It is a common saying that the only comfortable way to eat a mango is to eat it while you are taking a bath.

Do you know in what months the flowers and fruit are found on the mango-trees? Do you know whether they are found at the same time in all parts of the Islands? It is true that the flowers and fruit of many kinds of plants do not appear at the same time in all parts of the Islands. This is because the rainy seasons and the dry seasons do not come at the same time to the whole archipelago. The rainy season usually does not come to the eastern side of the archipelago at the same time that it comes to the western side. Now in many plants the time of flower-bearing depends upon the different seasons. Some plants, like gumamela and papaya, seem to bear flowers the whole year long. There are many more plants, however, which have only certain times of the year for producing flowers, and the mango is one of these. So it may be that when the mango-trees are bearing flowers in one part of the Islands, they may be found without flowers in another part. Yet it is usual for the mango-flowers to begin in late December, and the very first, high-priced mangoes are sometimes gathered in January. From January until June the small, fragrant blossoms are very abundant, and their pleasant odor perfumes the air all about the graceful tree. There is much pleasure in having a mango-tree near your house at this season.

Probably you have all seen men cut the bark of mango-trees with their bolos. It is hard to find one whose bark is not scarred



Mango.

by old bolo-cuts. You know that this is done to hasten the coming of the fruit. Men also build fires under the large branches in early morning, believing that if smoke spreads among the branches at that time the fruit will be better and will ripen more quickly. It is not easy to explain why the smoking and cutting help the fruit, but you may understand this when you have studied botany, which is the science of plants.

It is believed that the mango is not a native plant of the Philippines, but that it was brought here many years ago from India. Yet it seems in these days to grow even better in the Philippines than it does in India. There are many other useful and common plants which are not native to the Islands, but which were brought here from other countries. The Spaniards brought many plants from Spain and the West Indies. Even to-day the Agricultural Bureau of the Government is trying to introduce into the Philippines many of the useful plants of other countries. Very often plants which are introduced into new countries grow there even better than they did in their old homes.

For a tropical plant, the mango is slow in growing. You must remember that plants usually grow much faster in the tropics than in temperate regions, since they do not have to stop growth in the winter. Yet the mango requires at least ten years before it will bear fruit. When you think of the quick growth of papaya and banana this seems a long time, yet it is no longer than the time required by most of the fruit-trees of temperate regions. The slow growth of the mango-tree is one of the reasons why the fruit is more expensive than other kinds of Philippine fruits. If mangoes could be shipped like bananas to the great cities of temperate regions, they would be sure to sell for a very good price. It seems impossible to keep them from decay more than a few days after they are picked, even if they are picked before they are ripe.

The small, whitish flowers of mango grow in luxuriant inflorescences. There are always hundreds, yes, even thousands, more of flowers on the tree than there ever are of fruits. This is also true of the apple-trees of America. In spring they are covered over with fragrant pink and white blossoms. Nothing is more beautiful than an apple-orchard in full bloom. This great abundance of flowers seems to be a plan which the tree has for making sure of a good crop of fruit. Thousands of the blossoms must die without producing fruit, yet even then there may be as much fruit as the tree can carry. Always there are accidents which destroy many of the flowers, and the fruit which first begins to grow crowds out many others which are near it. It is the same way in macahia. The tree seems to understand this and know that it is a good thing to produce a hundred flowers to be sure of getting one fruit.

Perhaps the greatest enemy of the flowers of mango is the rain. They never begin to appear until after the regular rainy season is over. Then, if heavy rains come while the trees are in bloom, thousands of the tender blossoms are beaten to the ground. Perhaps you have heard the true saying that a good year for the rice is a bad year for the mangoes. When heavy rains come and injure the mango-crop they help the rice-crop. There is another true saying that the best years for mangoes are likely to be years of much sickness among the people because there is little rain.

Very many of the mango-trees in the Philippines seem to have been blown over. The main trunk lies along the ground. From this we may conclude that the roots do not go deeply into the ground, but are shallow. It does not seem to injure the vitality of the mango-tree to be upset in this way. It keeps on growing and bearing fruit as well as ever. Its long, shiny leaves are very abundant and form an excellent wind-screen for plants like cacao or coffee, which love a still air.

CHAPTER XXII

THE SOIL

You have learned that animals can not live without plants. Plants are the great source of food for animals. You are now to learn that plants, with very few exceptions, can not live without soil. Soil is the great source of material out of which plants make food. The air also supplies a necessary part of the food-material, but air does not have so great an effect upon plants as the soil. Air is almost exactly the same the world round and it comes to all plants alike, but soil is of many kinds and each kind has a different effect upon plants.

Soil comes from two sources. It is made of decomposed or broken-down rock and of material which comes from living things, as the leaves and branches which fall in a forest. If you are to understand how the soil has been formed, you must try first to think of the time when there was no soil. Perhaps you have already learned that men believe that ages ago, before there were living things on the earth, the whole surface was covered with rock. In our time we find the land-surfaces nearly all covered with soil, but if we dig down we soon come to solid rock.

The most important things which are at work to-day in breaking up rock into soil are, air, water, changes of temperature, and living things. Since there were no living things on the earth at first, and since there can be no living things without soil, we must try to understand how the first soil was formed without their aid. First, let us think of the work which the air did. Air is composed of three gases, oxygen, nitrogen, and carbonic-acid gas. Now the last of these three gases has the power of changing some of the material of which rock is composed from an insoluble into a soluble condition. Soluble means that the material will dissolve in water. Now many kinds of rock are built a good deal like a brick or stone wall. They are composed of many fine grains which are held together by a sort of cement. If this cement has been changed into a soluble condition by the action of one of the gases of the air, and then water falls on the rock, what do you suppose would happen? What do you suppose would happen if the cement of a brick wall were soluble and the wall were covered with water? You would soon have nothing left but a heap of bricks. The cement would all be dissolved by the water. And so it is with some kinds of rock. The water dissolves and washes away the material which has been made soluble, and leaves behind only grains of sand or soil. So you can see that this is one of the ways in which soil was formed from the rock without the help of living things.

In tropical regions, where the temperature is nearly the same the year round, it is not so easy to see the effect which changes of temperature have in breaking up the rock as it is in countries farther north or south. When water is changed to ice it increases its size. When winter comes the little crevices and cracks in the rocks are often filled with water. You can easily see that when this water turns to ice it will help split the rock into smaller pieces and so help in the great work of soil formation.

The thing which we can watch most easily at its work of changing rock into soil is the water as it runs in streams or dashes in waves against the shore. Then you can see how pieces of rock are ground against each other until they are worn to fine sand, which is one kind of soil. When the streams are high you can see that they are carrying along with them much soil which they have swept from their banks higher up in their course. Wet soil is called mud and a muddy stream leaves much soil along its course. Those of you who live near rivers have surely seen how much of the land on each side of the river is covered with soil which has been carried down from the upper parts of the stream at flood-time. Soil which has thus been carried and laid down by streams is called alluvial. Alluvial soil is excellent for the growing of cultivated plants. The fine tobacco-lands of the Cagayan valley are all covered with alluvial soil.

Soil composed of very fine grains which stick closely together when they are wet is called clay. A soil which is a mixture of clay and sand is called loam. Nearly all soils which have been formed by the work of rivers are loamy soils. Loam is better for the plants than either pure sand or pure clay. Pure sand does not hold water well enough, while pure clay holds it too well. Besides, clay is stiff and heavy so that it is difficult for the farmer to work it with his agricultural implements. Soil which is composed of the decaying parts of plants and animals is called humus, and this kind of soil is the richest of all in food-material for the plants.

In the cultivation of plants, perhaps the most important thing is the preparation of the soil. The process of breaking up soil so that plants can live in it better is called tillage. Plowing, harrowing, spading, raking; all are forms of tillage. Tillage helps the plants in many different ways. It makes it easier for the young roots to grow. There is much food-material in the soil which the plant can not use because it is not in a soluble condition. The little root-hairs can not take anything from the soil unless it is dissolved. Now the farmer when he plows his land lets the air reach all parts of the soil, and the air enriches the soil for the plant by changing food-material into a soluble condition. In time of drought, well-tilled land holds moisture in it much better than that which has been badly tilled. In tilling, the farmer can kill the troublesome plants, or weeds, which threaten to crowd out the plants which he is cultivating.

We have learned that by cultivation men can make plants grow much better than they do when they are wild. But there is a price for this improvement in the plants which the soil must pay. When plants are growing wild they never use up the food-material of the soil any faster than it is formed. One of the reasons why cultivated plants grow so much better than wild plants is because the farmer, by tillage and other means, gives the plants a chance to take from the soil as much as it can of the food-material which is there. The result of this is that after a few years the land becomes exhausted of food-material. The crops are better, but the land is poorer. This is one of the reasons why the farmer must give much attention to his land. If he grows tobacco on the same land, one year after another, the tobacco becomes poorer and poorer because the soil has become poor in the particular kind of food-material which tobacco loves.

There are several things which a farmer can do to keep his soil from becoming poor. One of the best things to do is to put fertilizers on it. A fertilizer is anything which is rich in food-material, and so makes the soil more fertile. Manure from the stables, guano, and rich humus are all good fertilizers. Another way to keep soil from becoming poor is by growing different kinds of plants in succession upon the same land. This is called "rotation of crops." It has been found that different plants require different kinds of food-material, so that when a piece of ground has become poor for tobacco, for example, it may be all right for corn. Then, after a few seasons, it may be all right for tobacco again.

The next chapter is about tobacco, a plant which is more easily affected by the soil than any other important economic plant of the Philippines.

CHAPTER XXIII

TOBACCO

Tobacco is used in all parts of the world, but perhaps nowhere more than in these Islands, where even the children often learn to smoke as soon as they learn to walk. It is said that no other plant-product, except tea, is used in so many countries and by so many people. It is remarkable that in both of these widely used plants it is the leaf, not the fruit, which is the valuable part.

Tobacco was not known in Europe until Sir Walter Raleigh, about three hundred years ago, brought it home to England from Virginia. It is said that when an old servant of Sir Walter's saw him smoking, he thought his master was on fire and quickly threw a pail of water over him. Tobacco soon became very popular in England, and in the days of the Colonies it was the most valuable crop grown in America.

This product is third in value of the exports of the Philippine Islands. Nearly six million dollars' worth in Philippine money is sent to other countries each year. Cagayan and Isabela are the best provinces for tobacco-growing, yet even in the excellent lands of the Cagayan valley the cultivation is imperfect. The three great processes in preparing tobacco for the market are cultivation, curing, and fermentation. Although Philippine tobacco is imperfectly cultivated, imperfectly cured, and imperfectly fermented, yet it is considered good. This plainly shows that the tobacco-lands of the Islands are very fine. The tobacco is good in spite of the imperfect treatment it receives.

The cultivation of this plant teaches us many important things. Not only does it give us knowledge which is valuable to the man who grows it, but it also illustrates some important things in plant-life which are also true for all plants. No plant cultivated in the tropics is so much affected by its surroundings as tobacco. It gives us an excellent illustration of the effects which surroundings may have upon plants in general. The valuable part of tobacco is the leaf, and leaves are more easily affected by their surroundings than are flowers or fruit. Thus you may often find the leaves of different plants of gumamela or culut-culutan very different in shape, while the flowers and fruit are exactly the same. So when the farmer wants to get a certain kind of leaf, instead of a certain kind of flower or fruit, you see that he has a more delicate problem. He must carefully study the peculiarities of his farm.

Tobacco is easily affected by climate, soil, elevation, nearness to the sea, light and shade, and methods of cultivation. A great deal of tobacco is grown in the United States, but it has never seemed possible to get leaves of such good flavor as those grown in a tropical climate, even through the most careful methods of cultivation have been used. Recently it has been found in Connecticut that by covering the fields of tobacco with cloth screens a much better kind of leaf is produced; almost as good as the leaves produced in

Tobacco.

Cuba. This plainly shows how easily leaves are affected by their surroundings.

Each new kind of soil gives new qualities to the leaf. Tobacco grown near salt water burns poorly. Valleys of the interior, whose deep soils have been laid down by streams, seem to be best for this crop. Good soil for tobacco is dry, warm, rich, deep, and somewhat sandy. The Philippine Islands have many interior valleys, where now only wild plants grow, which might be used for excellent tobacco-farms.

You know that as a cigar burns it leaves a great deal of ash. The material of this ash was taken from the soil on which the tobacco-plant grew. It once was food-material for the plant. Since the burning of tobacco gives so much ash, we may conclude that the plant is very greedy in its use of food-material. We can easily understand that where tobacco grows the soil must become poorer and poorer in the materials which compose this ash, unless a new supply is added each year. Many tobacco-planters use fertilizers each year to renew the supply of food-material.

Tobacco is one of the crops which are grown from seed and the seedlings are transplanted. Very young plants which have grown from seeds are called seedlings. Rice is grown in the same way, but tobacco requires more care than rice. The very small seeds are sown in good soil which has been selected and carefully prepared for "seed-beds." After two or three months the young plants are taken up from the seed-beds and set out in the fields. In Cagayan the seed is sown in late September or early October, and the young plants are transplanted in December.

The farmer must be very careful of his seed-beds. The soil must be very good and carefully tilled. The seed is mixed with sand or fine wood-ashes and spread smoothly over the surface. The surface is then rolled. The seeds are so small that forty-five grams are enough to sow one hectare of seed-bed. The beds need to be shaded after the planting, and shelters about three feet high are usually made of the leaves of nipa or cogon-grass. After a few weeks the shelters may be taken away. White ants and worms are the worst enemies of the young plants in the seed-beds.

When the young plants are taken up the farmer must be very careful not to break the little roots or the plants will not live in their new home. It is best to wash the soil away instead of trying to shake it off. The ends of the young roots are covered with hundreds of fine hairs, so small that they are difficult to see. These "root-hairs" are the things which do the important work of taking water and food-material from the soil into the plant. They have to be very delicate or the water would not pass into them. If they are all broken off, the little plant will not have time to form new ones in its new home before the leaves wither and die for the lack of water and food-material.

Except when he wishes to get seeds for planting, the tobacco-farmer usually pinches off the top of the stems of his plants before the flowers have begun to appear upon them. All the food which the plant makes then goes to build up the leaves. They grow to a much better size when the plant does not have to do the work of making flowers and fruit. The young side-shoots or "suckers" are also taken off so that the whole strength of the plant may be thrown into the leaves. Taking off the tops of the plants is called "topping." It must not be done too soon, or it will give too much growth to the leaves and make them coarse. If the farmer wants very thin leaves, it is sometimes better for him not to top the plants at all.

When the field-workers go about taking off the tops and the suckers they must also look out for worms. There are large tobacco-worms, like caterpillars in shape, which eat up the leaves very rapidly. They try to hide by getting on the under side of the leaves. Sometimes worms are found inside the stems.

After the leaves are gathered the work of drying or curing must begin. The leaves are gathered on bamboo-sticks and then hung on strings. The curing takes about a month. After that the leaves may be tied in bundles and sent to the factories, for in the Philippines the work of fermentation is usually done at the factories. It is the fermentation of the leaves which gives them their good flavor in smoking. Fermentation is really the beginning of decay. The leaves are piled in heaps and then are pressed. Sometimes they are soaked in a kind of wine which helps to give them a pleasant flavor. This process takes another month and the leaves must be carefully watched for fear they may ferment a little too much. After fermentation the tobacco is ready to be made into cigars and cigarettes.

CHAPTER XXIV

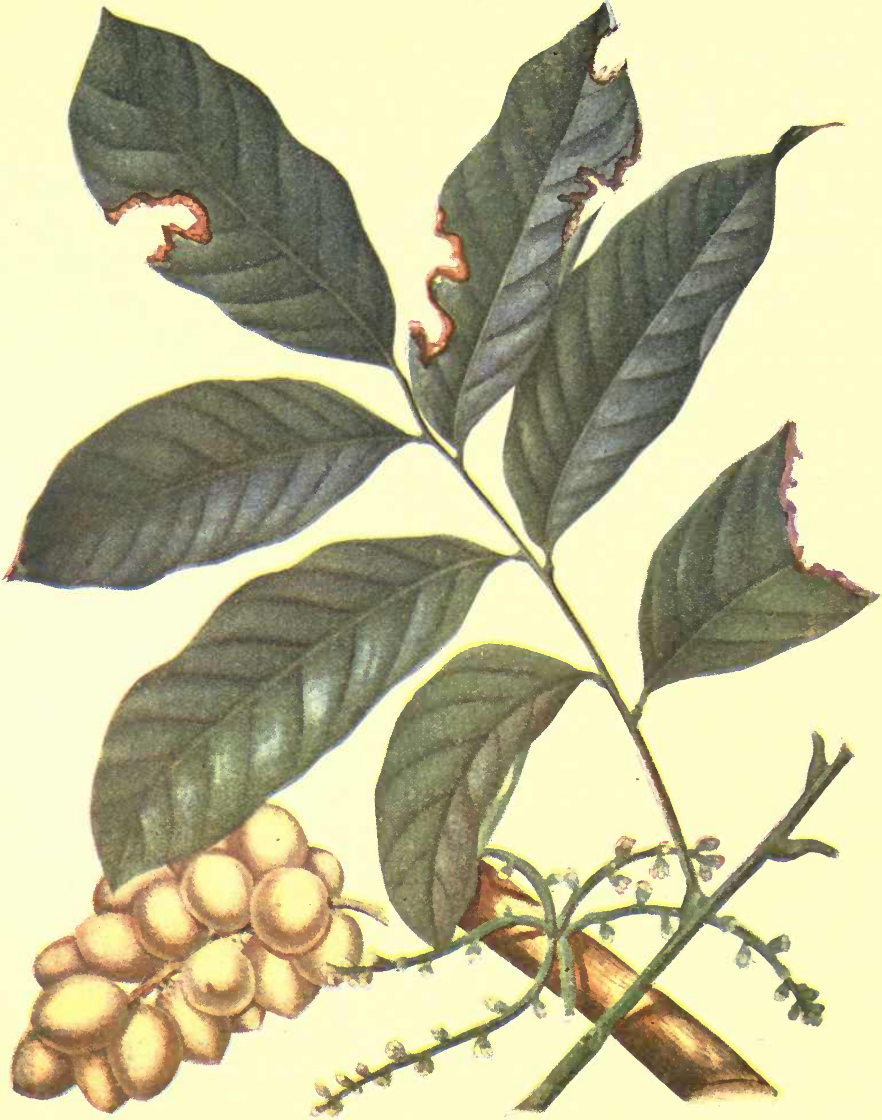
LANSONES

LANSONES grows best in the province of Laguna. In the month of October the boats which come from Laguna de Bay down the Pasig River to Manila are nearly always loaded with many great baskets of this delicious little fruit. Much of it is sold in the markets of Manila and at the fiestas.

The lansones is a native plant of the Philippines. It was never brought here from another country, like the mango from India. It does not grow in the countries of temperate regions. If you ask an American who has not been in the Islands very long whether he knows the lansones he is very apt to reply, "O, you mean the fruit which looks like a bunch of big yellow grapes." Every American is just as familiar with grapes as the Filipino is with lansones, and the bunches of lansones certainly have much the shape of bunches of grapes. If an American boy saw the picture of lansones he would probably be quite sure that he was looking at some kind of grape. Yet these two plants are really no more related than pandan and piña, whose fruits also look much alike. Though you may not have seen grapes growing, you probably know that the grape-plant is a vine, while lansones is a small tree. Wine is made from the juice of grapes. The skin of a grape is soft and sweet to the taste and the inside pulp slips out from it very easily. The skin of lansones is tough and bitter to taste and the pulp sticks closely to it. The grape has several small seeds while the lansones usually has but two which are of good size.

The lansones-tree is usually not more than twice the height of a man. It has a peculiar way of bearing its leaves. The petioles are very short, as you may see in the picture, but you can not see very well the natural position of the leaves. When the petioles of a leaf are very short the leaves of one branch usually lie all in the same direction, as the leaves of bayabas, but in lansones the leaves are turned in many directions. This is one way of keeping the leaves from shading each other. You have probably already seen that plants have many different ways of doing this same thing.

Lansones can show us very plainly the effect which cultivation has upon a plant. Since it is cultivated for the sake of its fruit, not for its leaves, the problem is not so difficult as in tobacco. Wild lansones, the very great-grandfather of the cultivated kind, is found in large numbers in some of the Philippine forests, especially in the



Lansones.

province of Bataan. The fruit of this wild form does not have a pleasant taste like the one which is cultivated. Also you will find that it contains five seeds.

Since lansones is cultivated because the soft pulp of the fruit is pleasant to eat, it is much better to have a fruit which has only one or two seeds in it, or best of all to get a fruit without any seed. You already know that the best kinds of bananas are those which have the smallest and weakest seeds. Sometimes a fruit of lansones is found which is all soft pulp inside and has no hard seeds at all. Have you ever seen one like this? Now the fruit of the wild lansones has five good seeds in it, and even in the cultivated form we find that the fruit is divided into five parts, each one of which is evidently for the purpose of holding a seed, although most of them are not developed. How do you suppose this plant could have been changed by cultivation so that it now bears fruit with only one or two seeds, and sometimes has no seeds at all? Let us see whether this matter can be explained a little.

You know that the natural work of flowers and fruit is to produce seed, so that the plant may be reproduced. You know that if the fruit does not bear good seed, the plant must produce its young in some other way. Thus, the banana produces its young by means of suckers. If the plant is successful in producing its young in some other way it seems to be willing to give up the seed-method. This, too, is illustrated by the banana which never produces good seed. So men by cultivation, by reproducing the plant by suckers and cuttings and not by seed, seem to change the natural work of fruit, or at least to relieve it of a good deal of that work. Thus it seems to be the natural work of the fruit of the cultivated lansones, not to produce good seed, but to produce much juicy pulp, pleasant to the taste.

Such a change as the one which has been made in the fruit of lansones, from the wild to the cultivated condition, can be made only in a great many years. To understand how this has been done by the many generations of people who have cultivated lansones in the Philippine Islands, you must understand that even the same kind of plant does not always bear exactly the same kind of fruit. The same kind of plant will produce better fruit when it grows on very good soil than when it grows on very poor soil. Differences in soil, water, and other things will produce a greater effect upon the leaves than they will upon the fruit, still the effect upon the fruit may be seen. So you might find a tree of wild lansones whose fruit tastes better and has smaller seeds than the fruit of its neighbors.

Now suppose you cut some good branches from this tree and transplant them to the soil near your house. The cultivation of lansones probably began in some such way as this. Then from the new trees you would cultivate again from the one which bore the best fruit, and give no more attention to the others. If this process is kept up for many years, and new trees always grown from cuttings and not from seeds, at last the plant may seem to give up the old habit of producing fruit for the sake of the seeds and seem to produce it only for the sake of its juicy pulp. Man, by cultivation, has relieved the plant of the work of producing seeds since he always takes care that the plant shall be well reproduced by cuttings from the old plants. Somewhat in this way there has been produced in California a kind of orange which is seedless. It should not be very hard by careful cultivation to get seedless fruit of lansones.

This same principle is true in the cultivation of all kinds of plants, whether they are cultivated for the sake of the fruit or for some other product. Seeds, when sown, usually produce plants exactly of the same kind as the one on which they grew. Yet it may happen that the new plant is a little different from the old one, and, if it is better, it should be carefully watched and young plants grown from it. In this way skilful cultivators often improve the fruits, or flowers, or leaves (as tobacco), or fibers (as hemp), or whatever else may be the useful product of the plant.

You can see in the picture the way in which the little flowers of lansones grow, scattered along the flower branches and are not crowded together. They seem to be leaving room for the growth of the fruit. Lansones seems to expect one fruit from each flower, and does not, like mango, produce thousands more of flowers than it can ever expect to bear of fruit.

CHAPTER XXV

THE COCONUT-PALM

No plant of the tropics is a better friend to man than the "Prince of Palms." No plant of the tropics is better known throughout the world. This name, Prince of Palms, has been given to the coconut. It is a name well deserved by this royal plant. The coconut-palm is both beautiful and bountiful. It loves to grow along sandy, tropical shores. It thrives where its roots are washed by the waves. There it may be seen in pleasant groves, each graceful tree with its splendid crown of leaves turned toward the sea, as though to welcome the ocean breezes.

The history of the coconut-palm goes back nearly as far as the history of man. Its native country no one knows. Even in the Philippine Islands there are sayings of the people which are older than written history, and which tell of the coconut. There is an old saying in the Visayan Islands that, " He who grinds the poor will grind water instead of oil from the meat of the coconut."

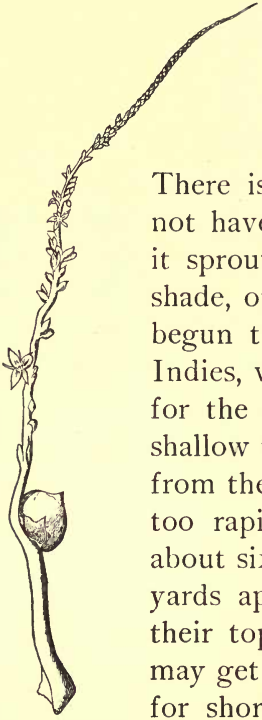
Like the mango, this is a Nature-Study subject about which Filipino boys and girls probably know more than they will find written in this short chapter. They know that the fruit of coconut gives food and drink and oil. They know that the leaves are good for thatching and for making baskets and mats. Rope is often made from the fibers of the rough husk of the nut, which is called the "coir," and from the outer part of the stems a beautifully marked kind of wood may be obtained.

Since it would take a whole chapter to tell simply of the uses of the coconut-palm, and you already know most of these, we had better give our attention to learning how the plant lives and produces its valuable fruit. Try to get one of the flower-bearing branches and see for yourself the two kinds of flowers. They are not beautiful or fragrant. They grow on a long, slender stalk which is called the "spadix." In one of the pictures you may see the way in which the flowers are arranged on the spadix. The few, round, female flowers are at the bottom, while the many, small, male flowers are scattered along the upper part. The male flowers nearest the bottom are the first to open their three, stiff, little sepals. Inside these protecting sepals we find six stamens, but no petals.

The female flower is more difficult to understand. It seems to be formed of nothing more than the round, hard ovary, which gradually changes into the fruit. This fruit contains but a single seed. The whole fruit, inside the outer covering, is really just one big seed. The white meat, or "kernel," of the coconut is the food which has been stored up for the use of the baby plant, or "embryo," which lies embedded in this white, oily meat. Perhaps you can

Coconut-palm.

find the embryo. It looks much like the meat which surrounds it, and is about the size of a small marble. It lies at the end from which the young plant begins to grow when the coconut sprouts. A fruit which has a hard outer coat, and contains only one seed, is called a "nut." The coconut is the largest kind of nut in the world.



Inflorescence of coconut-palm.

There is so much moisture in a coconut that it does not have to be placed in the ground in order to make it sprout. It is common to hang up the nuts in the shade, or pile them in little heaps, and, after they have begun to sprout, they are transplanted. In the West Indies, where coconuts are grown on many plantations for the northern markets, the seed-nuts are placed in shallow trenches, and covered with trash to shelter them from the sun and keep the moisture from evaporating too rapidly. They are left in these nursery-beds for about six months, and then planted in holes at least ten yards apart. The young plants are put down so that their tops just come to the surface, so that the roots may get a firm hold on the soil. It is quite necessary for shore-loving plants that the roots should be well fastened in the soil, else high winds would be certain to overturn them.

Coconut-palms should be planted either on alluvial soil, near the mouths of rivers, or on sandy soil along the shores of the sea. In five years they will bear flowers, and in two years more the first crop of fruit may be gathered. Seven years is a long time to wait for the crop, but then the tree seems to make up for lost time by bearing a great deal of fruit, and producing it all the year round. Seventy-five nuts each year is a good average, but some trees produce over two hundred.

There is a tree on a coconut-plantation near Zamboanga which has never failed for twenty-three years to produce two hundred coconuts each year. On this plantation many new plants have been set out in past years, but it has not been the plan to take the seeds for planting from the tree which bore two hundred nuts any more than from the other trees. You can understand, from your study of the cultivation of lanzones, how much better it would be always to take the seeds for planting from the most productive trees.

When we examine a ripe coconut the first thing we see is the rough, fibrous, outer coat. This is the part called the coir. When the nut is broken open, the milk runs out from the center, and we can see the white meat, or kernel, which lines the shell. This meat, when well dried, is called "copra," and it is the most valuable product of the coconut. Much of it is prepared in the Philippines and other tropical islands. A great deal is shipped to Marseilles, in France, and there it is prepared, in different forms, for the markets of the world. Coconut-oil is extracted from the copra, and the part which remains is used in the manufacture of a number of other products. The factories of Marseilles make a large profit in manufacturing the products of copra, and it would be far better for the coconut industry in the Philippine Islands if we had our own factories for this purpose.

It is common for Filipino coconut-growers to throw away the husks. Often you may see thousands of them piled up near coconut-plantations and left to decay. This is a wasteful practice, for the fibers of these husks have commercial value for rope-making. The coconut-grower could make a good profit if he would take the trouble of preparing these fibers for the market. Machines are used at many factories for separating the nuts from the husks. This work, which is all done by hand in the Philippines, can be done by one of these machines at the rate of five hundred to a thousand nuts in an hour. The husks are kept just as carefully as the nuts themselves.

We can easily understand what these thick, fibrous husks are for when we think of the height of the coconut-trees and the weight of the nuts. If they were not protected by these husks, the nuts would be quite sure to burst open when they fall to the ground. Then the milk would escape and they would decay long before the embryo had grown into a young plant. Of course the nuts are picked and not allowed to fall to the ground when they are gathered for the market, but the plant had probably learned to protect its fruit with a heavy husk long before men, or even monkeys, had learned to climb the trees to get them.

Two of the worst enemies of the coconut are rats and beetles. There is a kind of rat which makes its nests in the trash which collects in the axils of the big leaves and then preys on the young nuts. The beetle which preys on the coconut is called the "rhinoceros-beetle." It is very strong and bores its way into the stem. Its favorite place of attack is the axils of the young leaves. A good protection is to place handfuls of sand in these places.

CHAPTER XXVI

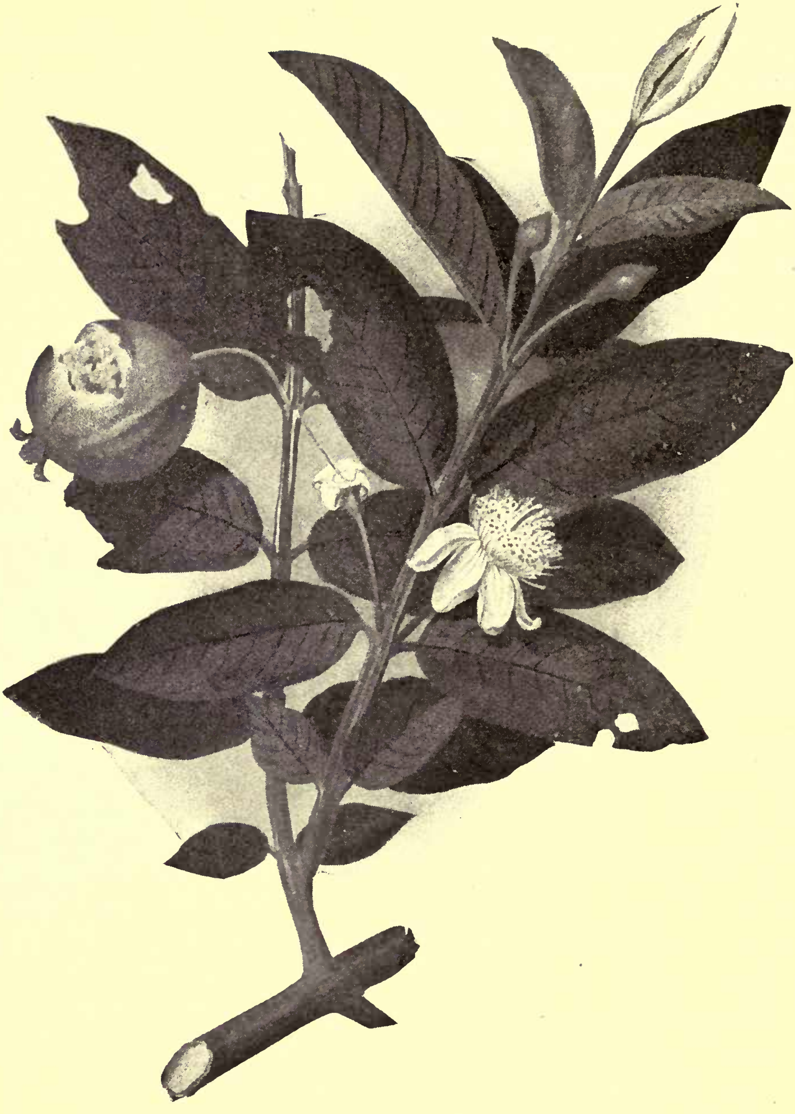
GUAVA OR BAYABAS

THE guava is one of the best-known tropical fruits. It is common in the Eastern and Western tropics alike. Guava-jelly is one of the most delicious of preserves and is sold all over the world. Some people are fond of the fruit just as it is picked from the tree, but is better when eaten with sugar.

There are several kinds of guava. One is a shrub, while another is a large tree from which beautiful wood is obtained. But the common kind of guava is a small tree, usually about twelve feet high, with simple, opposite leaves and small, white flowers. Surely you have all seen it growing near the houses, and have gathered the ripe fruit with a long stick and a bent wire.

There has been much dispute among botanists in the Philippines as to whether guava is a native plant of the Islands or has been introduced from a foreign country. Some were very sure that the guava is an introduced plant, but Padre Blanco proved that it is native to the Islands. Blanco was an Augustinian, and, until his death in 1845, was the greatest botanist in the Philippines. In his famous work, the Flora Filipinas, he tells how he found that guava must surely have been here long before the Spaniards came to the Islands. Padre Blanco traveled very much in the Islands and studied Nature carefully wherever he went. In the southern part of Luzon he once examined some rock which had been formed from the lava which had been poured out of a volcano in an eruption many hundreds of years before. You have all heard of the famous volcanoes of Taal and Mayon. There is a picture of Mayon on the Philippine money. You may wonder how he proved that guava is not an introduced plant by examining some volcanic rock, but that is just what he did.

When there is an eruption of a volcano much lava pours from the mouth or crater at the top of the peak. This hot lava is nothing more than melted rock, and when at last it becomes cool it is quite as hard as any other kind of rock. When the lava runs down



Guava, or bayabas.

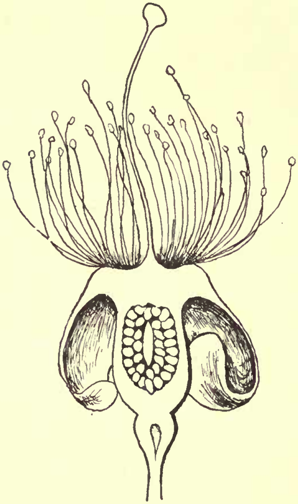
the sides of the volcano and spreads over the surrounding lands, the plants, and sometimes people too, are buried alive. After many years some one may come and break open the lava-rock and find there the exact forms of the things which were buried under the flood of lava at the time of the eruption.

Now when Padre Blanco broke open a piece of lava-rock in southern Luzon he found there the outline of a leaf of guava. It was exactly like the leaves which the guava-plant bears to-day. Even the fine veins could be seen. After a while the fruit of guava was also found. These forms of once-living things which are found in rocks are called "fossils." Now when Padre Blanco found the fossils of guava leaves and fruit, he had proved that guava grew in the Islands long before the Spaniards came, for it had already been proved that the volcanic eruption which buried these leaves and fruit must have occurred long before white men came to these shores.

Now let us look at the live guava-plant of to-day. When you feel its hard, tough leaves with their strong veins and midrib you can better understand how they might leave their outline printed in the rocks where thinner and more delicate leaves would leave no trace at all. The leaf of guava has a very symmetrical arrangement of the veins. After you have once examined it you may tell guava from the leaves even if you do not see the rest of the plant. So we say that it has a very characteristic leaf. It was because guava has a characteristic leaf that Padre Blanco could be sure of the identity of the fossils which he found. Many other plants have leaves so very much alike that we could not be at all sure of their identity if we had to judge from the leaves alone.

You will nearly always find that some of the leaves of guava have holes in them, such as you see in the picture. These holes have been made by insects. Have you ever seen leaf-eating insects at work on the leaves of guava?

The leaves are opposite and have very short petioles. In pandacaqui we also found opposite leaves with short petioles, but they are very differently arranged on the stem from those of guava. Each pair of leaves of pandacaqui is at right angles to the pair just above and the pair just below. This arrangement prevents them from shading each other. Now in guava we find that the pairs of leaves are not at right angles to each other, but all lie in nearly the same plane. Can you explain the reason for the difference in these two arrangements? Perhaps you can find an explanation in the fact that the stems of pandacaqui have nearly a vertical position, while the branches of guava are nearly horizontal.



Flower of guava, cut in half.

The young parts of the branches of guava have a character which disappears when they become older. They are four-sided instead of round, like the older parts, and each of the four edges has a soft, green ridge running along it. This is one of the characters of the plant for which we can not well give a reason, but which is important to remember because such peculiarities help us in telling different plants apart.

The flower of guava is quite different from those you have studied before. If you are reading this chapter at a time when the guava-trees near your home are in bloom, you should be sure to get some and examine them carefully. You can always learn about

Nature much better by studying Nature herself than by looking at pictures, no matter how good the pictures may be.

Perhaps the first things which you notice in the picture of the guava-flower are that the stamens are very many, and that the ovary is beneath both the sepals and the petals. When an ovary has this position, which you have already seen in the flower of banana, it is said to be inferior; that is, it is inferior or below the calyx and corolla. In most of the flowers which you have studied the ovary has been found above the bottom of the corolla. An ovary in this position is said to be superior. Now plants are divided into different groups according to the character of their flower-parts, and the character of the ovary is one of the most important things to notice if we care to know to what great group a plant belongs.

The flower of guava is a good deal like the flower of the apple-trees of America, of which you have heard so much. They, too, are white, often pinkish-white, and have many stamens and an inferior ovary. After pollination the ovary begins to turn into fruit, and since the ovary is really in the top of the stem, a good deal of the part of the fruit which we eat is formed from the top of the stem.

Another peculiar thing about the flower of guava is that, although the petals soon fall off, the stamens and sepals remain fastened to the top of the fruit long after their work has been finished. For this reason the sepals of such plants as guava are called "persistent." The seed of guava is scattered by birds which are very fond of pecking at the ripe fruit. We may be sure that the edible part of the fruit is more for the purpose of attracting birds than for attracting men.

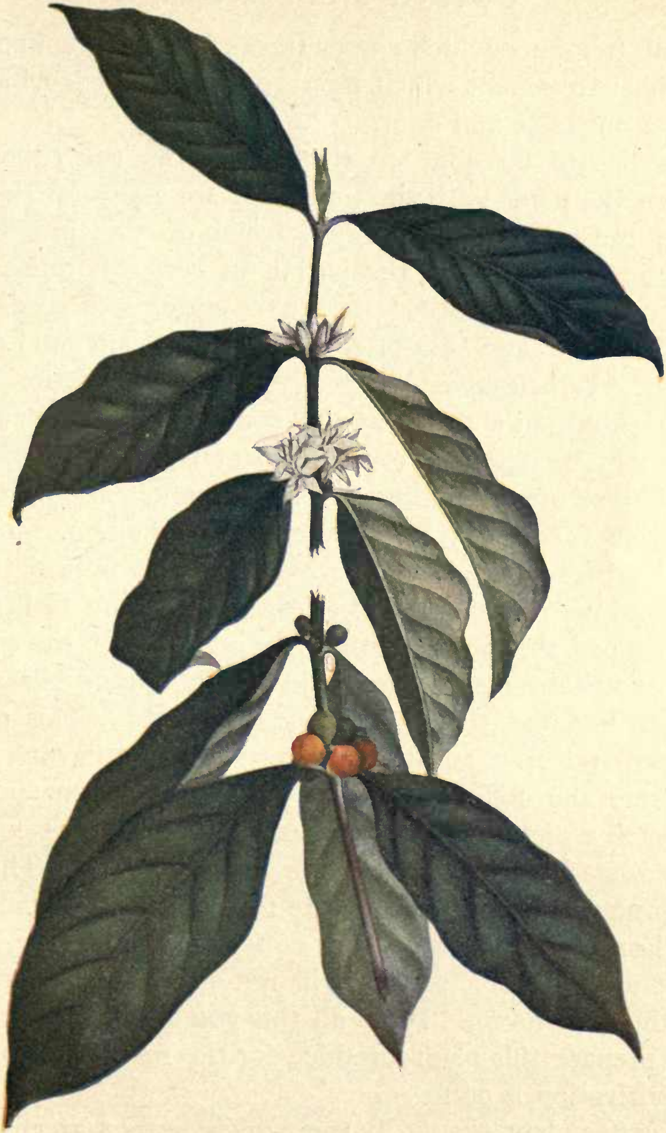
CHAPTER XXVII

COFFEE

Coffee and tea are the two most common kinds of drinks which are made from plants. Both are largely used in all parts of the world and there is always a good market-price for them. They are considered necessities by most people, yet the drinking of too much coffee or tea is certainly not good for one's health.

Tea is made from the leaves of the tea-plant, but in the coffee-plant it is the seeds which are the valuable part. In each fruit or "berry" of this plant two seeds are found. (A small fruit which has a soft pulp is often called a berry, just as long, narrow fruits which have the seeds in a row are called pods.) The coffee-berries are soft, round, and dark red when they are ripe. They are about a third of an inch in diameter. Inside the berry two hard seeds are found which take up most of the space. They are shaped something like beans, and are snugly packed in the pulp with their flat sides facing each other. You have probably often noticed that the coffee-beans which are sold in the market have one flat side, while the rest is round. This is on account of the way in which the beans are formed; two in a berry and facing each other. The young ovules of coffee are round, but as they grow into seeds they press against each other and become flat on one side.

When coffee beans are ready for the coffee-pot they are brown, but when they are on the plant they are never brown, nor do they have the pleasant odor which comes from them when they are ready for use. No matter how much you might examine a coffee-plant in the natural condition you would never detect anything like



Coffee.

the pleasant fragrance which comes from a steaming coffee-pot. It is the artificial treatment which men give to the seeds which brings out the pleasant taste and odor.

Much has to be done to the seeds from the time they are picked from the plant until the time they are ready for the market. First, they must be cured. You learned of this process in the chapter about tobacco, but the curing of coffee is quite different from the curing of tobacco. In coffee-curing the seeds are first cleaned of the pulp and skin of the berry which surround them, and then dried. Well-cured coffee is dry, hard, and brittle. It has a deep-green color and a strong and pleasant smell. After the coffee is cured, it may be shipped from the plantations to the mills where the rest of the work preparing it for the market is done. On the docks of New York and San Francisco may be seen thousands of sacks of this green, cured coffee, which has been brought from the coffee-plantations of the West Indies, Mexico, and Central America. It is hoped that in the future a good share of the coffee used in the United States may be grown in the Philippine Islands.

After it is cured, the coffee must be roasted. This makes the beans brown and crisp and brings out their good flavor. Now for the first time the coffee begins to have the pleasant odor which makes it such a popular drink. Roasting does for the coffee-beans just about what fermentation does for tobacco-leaves. The roasting must be done very carefully if we are to have a good quality.

The last process in preparing coffee for use in the kitchen is to grind it up in a mill. Coffee will not have a rich flavor if it is boiled without grinding. From all this you see that it is no simple matter to prepare this plant product for the market even after the work of cultivation is done.

The coffee-plant is a small tree which bears a great number of berries. The flowers, as you can see in the picture, are borne in inflorescences at the joints of the branches. Since the fruit is hardly larger than the flower, there is room for a berry to be formed from each blossom. The flowers are very pretty, with their five white petals and five long stamens with red anthers. They have a pleasant odor. The beauty of a coffee-plantation does not disappear when the flowers are gone, for the red berries, showing through the dark-green leaves, make a fine sight.

The trees are usually well trimmed and set out in straight rows. Like tobacco-plants, the coffee is "topped" when it is young, but of course not for the same reason. If the top is nipped off when the plant is three or four feet high, the side branches will grow and spread out. This makes it much easier to pick the fruit and the trees are not so much exposed to the high winds.

Coffee-trees, like cacao, need shade when they are young. Banana-plants are often used for this purpose. When the tree is old enough to bear fruit, the shade-plants may be removed, for mature coffee can stand a good deal of sunlight.

When land is cleared for starting a coffee-plantation, the bushes and weeds should be left to rot for fertilizers. The plants should be grown from seed in special beds where the soil is moist, rich, and deep. These are often called "nursery-beds." (A plant-nursery is any place where young plants, usually young trees, are grown to be transplanted after they have a good start.) Coffee-seeds are sown fresh from the berries and are set a few inches apart. The young plants must be kept free from weeds and well watered. Coffee likes a loamy soil. Clay is too stiff.

When the young trees are set out in the fields they should be put about six feet from each other. Since they like plenty of air and sunlight, they can not be planted as close as cacao. In the places where the young trees are set out the soil must be carefully loosened and all stones taken out.

After the young trees have begun to grow vigorously in their new home, the side-shoots or suckers should be cut away, as in tobacco-culture. If all the shoots are allowed to grow, the tree becomes thick and matted, so that air and light do not get to the center very well and the crop is poor. This cutting away of the unnecessary branches of a tree is called "pruning."

The berries should be gathered when they have turned red. A machine called a "pulper" is usually used to separate the seeds from the rest of the berry. This machine has a rough roller which crushes the berries. Below the roller there is a sloping sieve down which the mashed-up pulp rolls away, while the seeds drop through it. Then the seeds are put in a tank for a day or two, so that the pulp which still sticks to them may be washed away. After that the seeds are ready to be dried.

A coffee plantation.

Coffee is grown in several different places in the Philippine Islands, but especially in the province of Batangas. Much has been planted near the town of San Pablo. It is usually better to grow coffee at least a few hundred feet above sea-level. This is one reason why the Agricultural Bureau has chosen Lipa, in the province of Batangas, for the site of its experimental coffee-plantation. Some excellent coffee is grown in northern Luzon, but coffee-growing may still be called one of the "infant industries" of the Philippines.

CHAPTER XXVIII

PIÑA OR PINEAPPLE

PIÑA is one of the economic plants of the Philippines which has two very different uses, for both of which it is excellent. What are these uses?

In the first chapter about pandan you learned that the fruit of piña is called in English a pineapple, though in many of the English colonies it is called simply a "pine." In the United States it is called pineapple, though it would indeed be difficult to find any fruit which looks less like an apple than this one.

The pineapple grows only in the tropics, yet it may be sent to all parts of the temperate regions without danger of decay if it is carefully packed. So this excellent fruit has become well known all over the world. Its peculiar, sweet taste has made it very popular. Of the fruits shipped from the American tropics into the United States, the banana alone is more important than the pineapple.

Though this fruit is very agreeable to eat, it is not very easy to digest. It does not have such good food-qualities as the fruit of banana or papaya. Its pulp is not so soft and nutritious. You are almost sure to be ill if you eat too much of it. Padre Blanco writes that Filipino boys sometimes bleed at the mouth from eating too much pineapple. Has it ever made you sick?

Though the pineapple is not a native plant of the Philippines, it may be cultivated in all parts of the Islands. In the Visayan group this plant is grown especially for the sake of its leaves. Surely you are all familiar with the delicate fabric which is made from the fine fibers of the leaves of the pineapple. This piña cloth is one of the best-known products of the Philippines. Much of it is made in Iloilo. Another cloth, known as pineapple linen, is made in China from these same leaves.

Have you ever seen the pineapple growing? Have you ever looked for the stem? If so, you have surely been disappointed, for the pineapple is practically a stemless plant. It has a cluster of stiff, sharply pointed leaves which grow close to the ground. From the center of this cluster of leaves, the flower-branch arises, carrying a close inflorescence of blue flowers. It is from this whole inflorescence that the fruit is formed, just as the fruit of pandan is formed from the inflorescence of female flowers. So, you see, the plant seems to have no need for a stem. The sharp-pointed, erect leaves are evidently arranged for growing in bright places, where the plant does not need a stem to lift its leaves up into the light. Since the plant is not a wind-lover, there is no need to lift the flowers up where the wind would be sure to strike them. This plant saves the work of making a stem.

The cultivation of the pineapple is quite simple. It does not need much attention, and seems to have few enemies. The thick leaves do not easily die when there is little water. Of all cultivated plants, probably the pineapple needs the least water, and can live best where the soil is not rich. If you are going to start a garden of pineapples, it is best to set out the little suckers which come

Piña, or pineapple.

from the base of the mature plants. Another way is to transplant the tuft of leaves which grows above the fruit, but this method does not seem to be so good as the other.

The strong spines which grow from the edges of the leaves make the pineapples rather difficult to handle. In many tropical countries, especially in the West Indies, this plant is cultivated on large farms. When the men work among them they wear leggings and stiff gloves to protect themselves against the spines. Can you understand the purpose of these spines? Since the pineapple is able to grow in places which are dry and hot, where plants with tender leaves can not grow, it has all the more need to protect itself from leaf-eating animals.

Have you ever noticed the seeds of the pineapple? Can you see them when you cut a fruit in slices to eat it? You may look at the fruit a long time without ever noticing the seeds. Not even seeds so small and weak as those of lacatan are to be found in the center of the fruit, but if you look carefully at the outer part you may find them. They are borne very close to the outer skin, and are usually very small. There are other well-known fruits which do not have their seeds in the center. Probably you have all heard of the strawberry and have seen pictures of it. It is one of the finest fruits of temperate regions. The strawberry carries its many small seeds on the outside of the fruit, so that the birds are sure to swallow them when they peck at it.

When pineapples are gathered, if they are to be shipped to other countries, they must be very gently handled and carefully packed, for they will quickly rot if the tough skin is bruised or injured in any way. So long as the skin is air-tight the fruit keeps very well. Like the bananas, if they are to be shipped, they must be gathered before they are ripe. They will ripen on the journey.

It is rather difficult to find the flowers of the pineapple, for they quickly disappear and the fruit begins to form. When flowers grow in such close inflorescences it does not take long to accomplish the work of pollination. Then the flowers disappear, for their part of the work of reproduction is done, and the plant gives its whole attention to forming the fruit. In the case of the pineapple this is rather a slow process, for a large, compound fruit is to be formed from the working together of many little flowers.

If you do find the flowers, you will see in each one three blue petals, six stamens, and a three-parted, fleshy stigma for receiving the pollen. The stamens are shorter than the petals, and the style is a little longer than the stamens. At the bottom of the flower you will find a small calyx. At the side of each flower is a stiff, little leaf, with sharp teeth, like the teeth of a saw, along its edges. These little leaves, with their saw-teeth, are there for the same purpose as the sharp spines along the edges of the large leaves. They are for protection against hungry and thirsty animals. Of course when the pineapple is growing in a garden it really needs no such protection, yet it tells us very plainly by its structure that its natural home is in dry and sandy places where a sort of coat-of-armor is much needed. Think how quickly the fruit of the pineapple would be eaten, before it is ripe, by hungry animals if it were not so well protected by its stiff and spiny coat! If we did not have knives for cutting it open, we would find the task of eating this fruit very difficult ourselves.

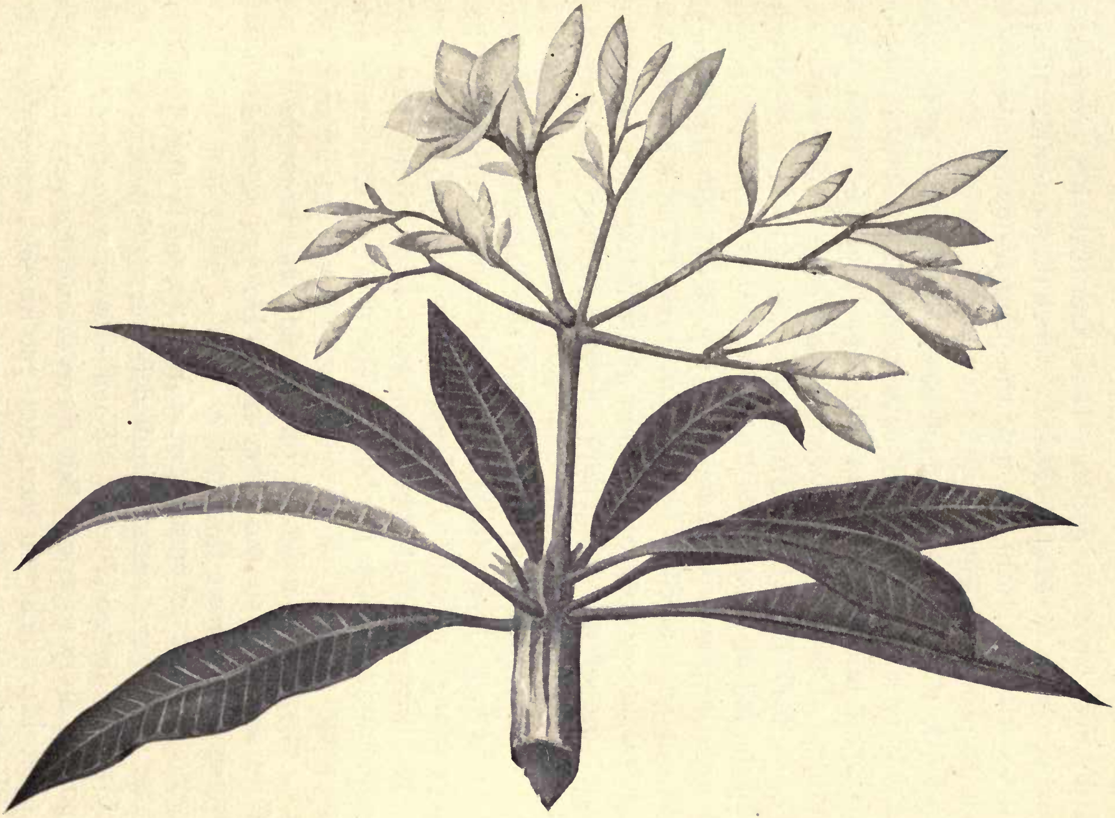
CHAPTER XXIX

CALACHUCHE

This strange little tree is to be found in many Philippine gardens. Its light-colored stems and branches, its large, leathery leaves, and its fragrant, white flowers are familiar to you all. Does it bear flowers all the year round, or only at certain seasons?

Calachuche is grown in other parts of the Oriental tropics quite as much as in the Philippine Islands, yet its native home is in the American tropics. For many years it has been much esteemed in India and Ceylon as a sacred plant. Great heaps of the fragrant blossoms are placed before the idol in Buddhist temples as a form of worship. From these same blossoms a pleasant perfume called frangipani is made. Here in the Philippines the flowers of calachuche are much prized for decorations, since they do not wilt easily. They keep their fresh look long after they are picked, and, as they slowly wither, the sweet odor seems to become even sweeter than before.

Have you ever looked for the stamens and pistil in the flowers of calachuche? Have you ever found them? Probably not, for the flower at first seems to be perfectly sterile. A sterile flower is one which produces no seed-making parts. The five white and yellow petals of calachuche unite in a tube, and nothing is to be seen of either stamens or pistil, which are the seed-making parts. Even when we cut the flower open there seems to be nothing inside the corolla, unless you look very carefully just at the bottom of the tube. There you may see some small structures, which, upon close examination, prove to be five stunted, or "dwarf," stamens. Can you find them? These dwarf stamens have sharply pointed anthers, but



Calachuche.

they hardly ever have any pollen. It is plain that they are parts of the plant which are no longer needed. Once they must have had an important work to perform, but now the plant seems to have almost forgotten to produce them.

Evidently this is a flower which has lost the power of seed-production. Very rarely is a fruit of calachuche found. This is another case of a plant under cultivation which has given up the work of seed-making. Do you know what means of reproduction it has instead of seeds? Does it have to be reproduced in an artificial way, that is by the aid of men?

Though the power of seed-making is gone, calachuche seems to still hold out an invitation to insect-visitors. The white corollas with their orange-colored centers and pleasant fragrance, are surely for the purpose of attracting flying insects. Have you ever seen any insects visiting them?

The petals are thick, which is one of the reasons why the flowers remain fresh so long after they have been taken from the tree. They have enough moisture in them to keep from drying out very soon, as the thin petals of gumamela do in a very short time after they have been taken from the bush. The petals of calachuche also have the peculiar habit of overlapping. The edge of each one covers the edge of its neighbor on one side, and is covered by the edge of its neighbor on the other side. Do you know any other flowers whose petals have this habit?

After all, there is nothing very new to us in the flower of calachuche. We have already studied flowers which have lost the power of producing good seed. Which flowers were they? That fact is an old story to you. But there is another very important fact of plant life which you have not yet learned, and which calachuche illustrates for us better than any plant which you have studied. That is the fact that rest is necessary for plants just as it is for animals. They can not work all the time. Have you ever seen a calachuche-tree at rest?

Some plants, of which the tree you call acacia is the most common example, seem to close their leaves at night. Have you ever noticed the acacia folding up the leaflets of its compound leaves about the time the sun goes down? This habit makes the acacia one of the most desirable trees to have near our houses and along our streets. In the daytime it gives a splendid shade, and at night its leaves fold up so that all the refreshing breeze can reach us. Do you know any plants besides acacia which close their leaves at night? Sometimes this closing of leaves at night is called the "sleep of plants," yet it should not be compared with the sleep of animals, for the plant is really at work all night long. The rest of plants is quite different from the folding up of leaves at night.

Now we can tell very easily when the calachuche is at rest, at least from the work of food-making, or leaf-work, for then it loses all its leaves. Some other common trees of the Philippine Islands lose all their leaves at one time. Cupang and dap-dap are examples. Do you know any others? Trees which remain for some months without leaves are not common in the tropics. They are the exceptions to a general rule. Most of the trees are covered with leaves the year round, yet we may be sure that even these trees do take a rest from leaf-work. They seem to be quite different from trees like calachuche, for one part of the tree rests and then another part; not the whole tree at once. While some branches, or parts of branches are at rest, all the other parts of the plant are hard at work. So, unless we watch the plant very carefully, it seems to us to be at work all the time.

This is a fact of plant life which is also illustrated by the way in which flowers appear. How many plants do you know which bear flowers the whole year round? Most plants seem to save up their strength for a particular season, and do the work of flower-bearing only at that time. Some plants bear flowers first on one part, then on another. The tree which you call ditaa is an example of such plants. The many, little, white flowers of ditaa appear first upon several branches. Then the tree seems to take a rest for two or three weeks. Then the flowers begin to appear again upon other branches. So the ditaa often seems to have three or four different times of flower-bearing, but really this is only because the work is not done by the whole plant at the same time. Perhaps this is because the plant can not make food enough to supply flowers upon all its branches at the same time. Have you ever noticed any plants besides ditaa which have this habit?

In the temperate regions, as you know, nearly all the trees lose their leaves as winter comes near. In the tropics there is no such general loss of the leaves at one time, and this is probably the greatest difference between plant life in temperate regions and that in the tropics. In temperate regions plants are forced to take their chief rest in the winter, for then water is turned to ice. You have already learned how necessary water is to plant-work. Yet you must not suppose that even in winter the trees are entirely at rest. Of course many small plants die when the cold weather comes, and grow up again from seeds or bulbs in the warm spring months. These are called annual plants. But the trees, which grow for many years, do not stop all their work in the winter. Deep under the ground, where the water does not turn to ice, their roots keep on growing.

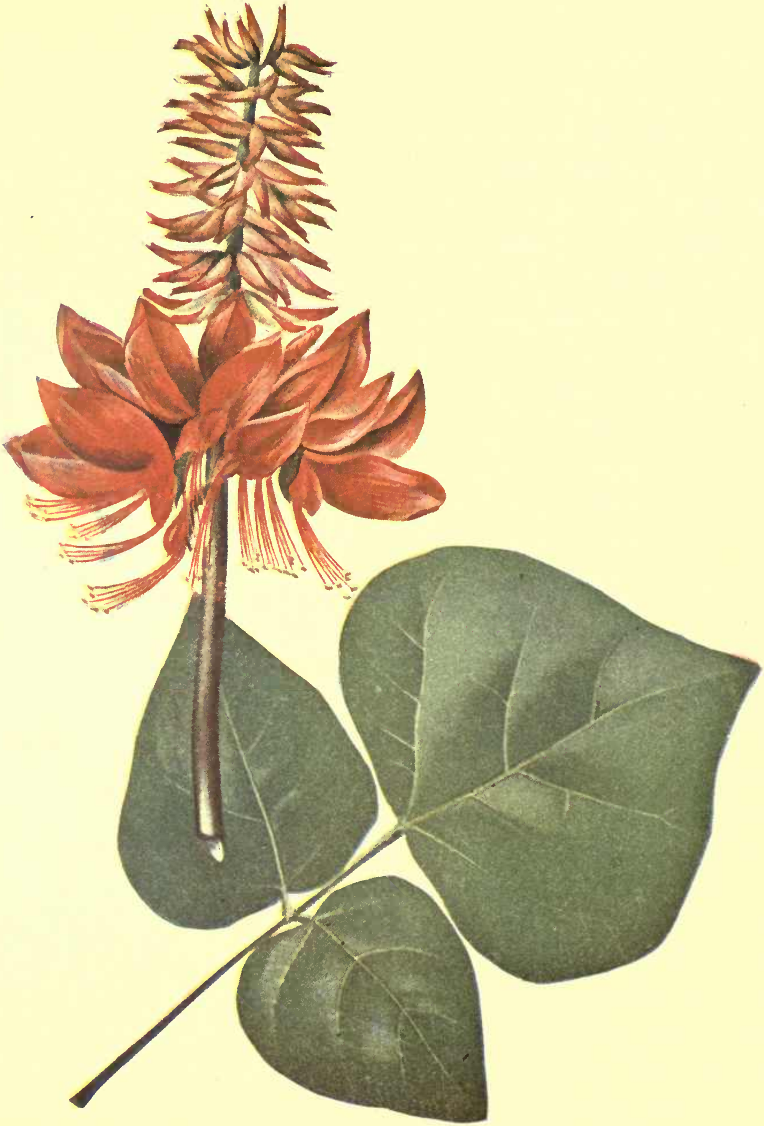
Now in the tropics there is usually no time of year at which the plants are forced to take their rest. They seem to be able to choose their own time for resting. The conditions of weather nearly always permit them to be at work, unless there is some other reason, which we cannot see, which prevents them. For this reason people often think that tropical plants work the whole year long. Yet we have learned that, even if the weather is always pleasant, the plants must rest at some time or other. Calachuche proves this to us. There seems to be no reason why it should not bear leaves at one time just about as well as at another, yet we know that it is always certain to take a long rest.

Have you ever noticed that the flowers of calachuche sometimes appear while the tree still has very few leaves? This shows us that the plant has stored up in its stem and roots enough food to produce these flowers without the help of the new leaves. You have learned that the green parts of plants are the only parts which can make food, and you know that nothing can grow when there is no food. So, when the plant grows while there are no green parts on it, we may be sure that a good deal of food was stored up when the leaves were at work before.

CHAPTER XXX

DAP-DAP AND SPANISH FLAG

THE awkward red flowers of dap-dap, and the very graceful red and yellow ones of Spanish Flag, are both quite different indeed from those you have already studied. A tree of dap-dap in full bloom is a very striking and handsome sight. The flowers are massed in large inflorescences, and the brilliant color of their large petals makes the tree as striking to the eye as though it were in



Dap-dap.

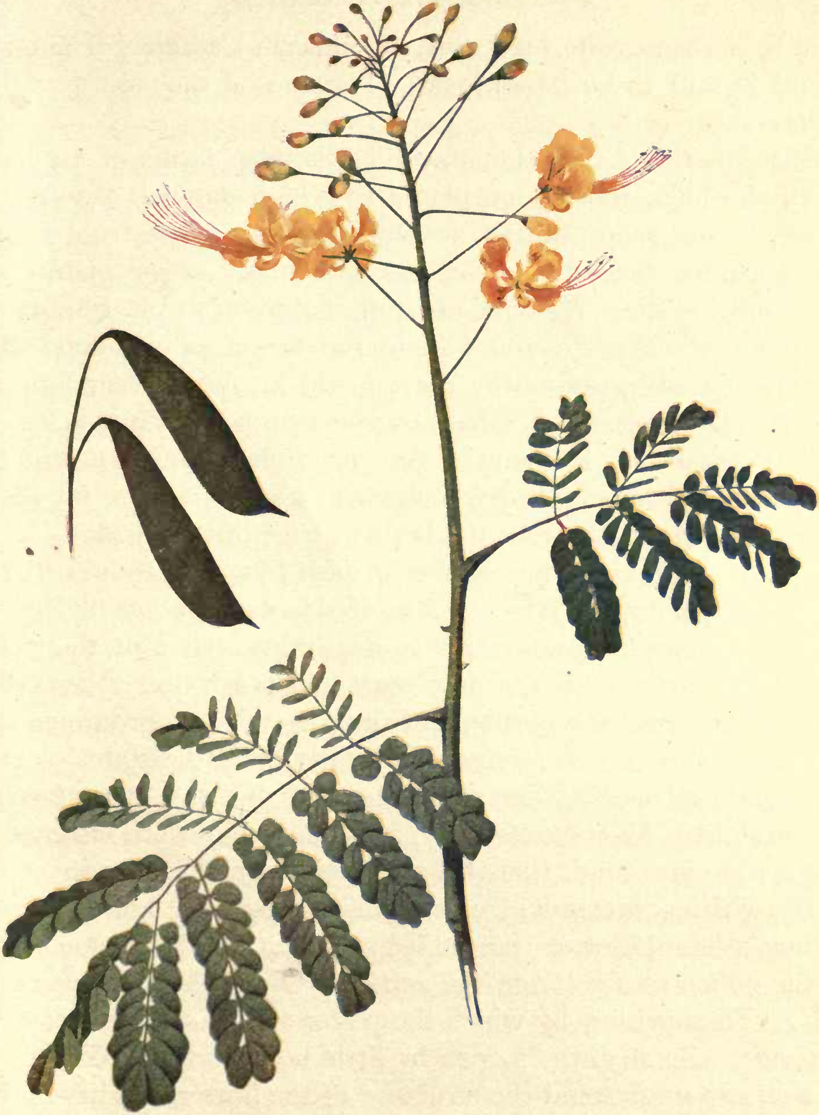
flames at night. Yet how awkward and graceless is a single one of the flowers of this handsome plant when it is separated from the inflorescence! Its loose, ungainly structure is only redeemed by its splendid color.

What flower is there, on the other hand, which has a more graceful and exquisite form than the Spanish Flag? Its beauty is made all the more evident by the dignified way in which the flowers are carried. The loose and slender-stemmed inflorescences of this plant give each flower ample room in which to extend its curving, separate petals. They are not huddled together in a close bunch as the flowers of dap-dap. It seems as though the dap-dap were trying to get the most striking color-effect by massing its brilliant flowers close together, at the same time concealing their ungainly shape. The Spanish Flag, however, has nothing to hide. How proudly it extends each petal and stamen, as though to invite close inspection! What the Spanish Flag loses in masses of color, it seems to make up in dignity and grace. Which of these two handsome flowers do you think would attract you first?

Dap-dap and Spanish Flag both belong to that great family of tropical plants which you learned about in the chapter on macahia, the family Leguminosæ, whose fruits are called pods. The plants which form one great division of this family bear flowers which are very irregular in structure, and the dap-dap is an example of this division. The macahia, on the other hand, belongs to another division whose flowers are quite regular. as you have seen for yourself. Now there is a third division whose flowers are less regular than those of macahia, but more regular than those of dap-dap. The Spanish Flag is an example of this division. You might well believe that flowers so different as these would belong to separate families, but their kinship is shown by the fruits they bear. Every one of them produces a pod-fruit which, as you know, is quite different from all other kinds of fruit.

The only other irregular flower which you have studied is that of butuhan, yet the corolla of butuhan is quite regular as compared with that of dap-dap. A regular flower is one which may be divided into similar halves in more than one way. It is said to have "radial symmetry," as a wheel has radial symmetry, because it may be divided into similar halves along different lines which pass through the center. Probably you have already learned that a line from the center to the outside of a circle is called a "radius," and that anything which has a regular shape is said to have "symmetry." Now it is very easy to see that neither the flower of dap-dap nor the flower of Spanish Flag has radial symmetry. So they are called irregular. Some of the most beautiful flowers that grow in the tropics are irregular. The orchids, which belong to the class of plants you call "dapo," are thought by most people to be the most beautiful of all flowers. They are all irregular. Each different shape is probably for the purpose of attracting a different kind of insect. You can better understand how important the work of cross-pollination is when you think of the many strange shapes and structures, colors and odors, which different flowers have, and which plants seem to have invented simply for the purpose of attracting insects.

The dap-dap is like calachuche in losing nearly all of its leaves in certain months of the year. Can you tell the months in which calachuche and dap-dap have no leaves? The leaves of dap-dap are compound and divided into three, large, heart-shaped leaflets, as you may see in the picture. It is quite exceptional to find a member of this great plant-family whose compound leaves are divided into only three leaflets. Usually there are several pairs of leaflets.



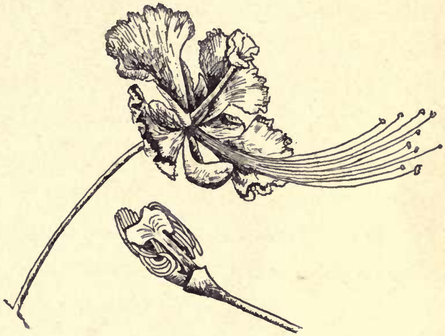
Spanish Flag.

as you have seen in the leaves of macahia and acacia. The one at the end is said to be "terminal." The ones at the side are said to be "lateral."

Do you think that the flower of dap-dap looks at all like a butterfly? That division of plants to which dap-dap belongs, on account of the shape of the flowers, takes its name from a Latin word meaning butterfly. Do you know any other plants with flowers of this shape? They are quite common in the Philippines. How many stamens do you find in the flower of dap-dap? Can you think of any reason why they should have such very long filaments? That long, slender part of the stamen which is below the anther is called the "filament." At what time of year can you find the pods of dap-dap? Do you know any useful purpose for them? Is medicine ever made from the bark or fruit of this plant?

If you can get a flower of the Spanish Flag you should study it carefully and compare it with that of dap-dap. Probably there is no other flower whose colors are so nearly like those of the flag of Spain. The anthers are the only parts which are not either red or yellow. They are dark purple, and since they are so prominent you can easily examine their structure. Nearly all anthers are joined to the filaments at one end, but the anthers of this flower are fastened in the middle. They move easily, as though they were fastened on a hinge. Do you think that this arrangement makes it more certain that the visiting insect will carry pollen away with him? Now if you look at an old flower, before it has begun to wither, you can see how the pollen escapes from the anther. Old anthers are open and empty. The opening by which the pollen has escaped is a long slit in the side. Some anthers open by little holes in the ends.

You can understand the structure of the flower best if you open a bud and see how the young parts are snugly packed away in their covering. The whole bud is covered by one of the sepals, which has the shape of a hood. When the flower is open this hood-shaped sepal is on the under side. You might easily mistake it for a petal unless you look carefully, for it is colored and much larger than the other sepals. Inside the bud you will find the ten stamens with their long filaments all very smoothly folded together. There are five petals, and they have three different shapes. The odd one stands up between the others at the top of the flower and is called the "standard." The hood-shaped sepal is sometimes called the "keel," because it resembles the keel of a boat. Have you ever noticed that the yellow color of the petals gradually fades as the flowers become older? Old flowers are almost entirely red. The pod of this plant is flat, as though it had been pressed. Do you know any other plants of this family which have flat pods? The compound leaves of Spanish Flag have seven or eight pairs of leaflets, and are folded up at night like the leaves of acacia.



A single flower of the Spanish Flag, and a bud with calyx and corolla removed.

Thus, each new plant which you examine will teach you much about the lives of plants, and their value and importance to man, who could not live without their help.

THE END

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